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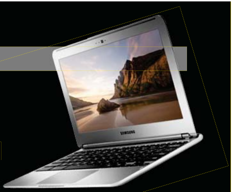

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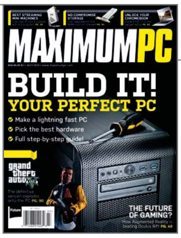

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Tuan
Nguyen

CHASING THE FUTURE

THERE ARE LITERALLY two things we care about here: what we can do with what we have right now, and what's coming tomorrow. Sometimes, things are going well enough that both the present and the future are equally exciting.

Take streaming, for example. I would call it a work in progress. The technology is there, but the infrastructure isn't. For now, the best way to stream anything is to do it locally, within your home, from one device to another. If you have a powerful gaming machine, you could technically stream its content to a TV in your living room. It's something you can do right now, with an inexpensive mini PC. We look at the best options this issue. But the future is in WAN streaming. Nvidia and others are trying to bring streaming technology mainstream, but Internet access infrastructure is still a bottleneck.

There's something coming in the near future that I'm really excited about: augmented reality. In the last two years or so, virtual reality has been all the rage, but from a practicality standpoint, AR shows significant promise because it can help with what we experience today. Ironically, AR has a good deal of its uses outside of the PC. The best thing of all is a lot of companies with deep pockets are investing into both AR and VR, so there'll be no shortage of innovation coming down the pipeline.

Your typical AR solution is a transparent lens, ideally placed in front of your eyes. Powered by some computational voodoo, the system is supposed to understand the world around you, and enhance what you see and the information you take in. Maybe I can use this technology to get the details on someone I approach at a bar before saying hi. Or maybe that's just a little bit creepy…

Moving back to the world of present-day desktops, we recently received a question from a reader that went a little something like this: "How do I build a PC that won't go obsolete?" I jokingly said on a podcast that a system is obsolete the minute you buy it. The funny thing about technology is that it keeps improving, but that means you keep chasing.

The often-asked question is really: "Should I wait until…?" I tend to think that if you play the waiting game, you can end up waiting forever, and waste a lot of productive time. Obviously, if an upgrade is being released tomorrow, you should definitely wait. The way I tend to go about things when I build a PC is look at what I'd like to do with it now, and then look a few months ahead at the content I want to be using. Of course, things become even harder if you previously spent out the nose on a setup that's now just a bit too slow.

The bottom line is that, sometimes, when you want to move forward, you have to leave something behind.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Valve Backs Off on Mod Monetization

Gabe Newell pulls controversial Steam payment system

IT'S NOT OFTEN that Valve gets booed for its attempts to improve Steam, but the long-beloved game company faced the fury of the Internet after its controversial decision to allow for the monetization of mods. The feature rolled out on April 23, with Bethesda's popular *Skyrim* RPG being the first game to take advantage of the system. While giving modders a chance to make money from their mods doesn't sound too controversial, Valve's implementation of its system was met with great criticism.

One of the biggest issues people had with it was the distribution of funds: Modders would receive 25 percent of the revenue for each mod sold; according to Bethesda, Valve would take its standard 30 percent cut; this left 45 percent going to Bethesda. Many people took issue with that, feeling that the lion's share of the profits should have gone to the modders. On the flip side, a lot of people also felt passionately that mods should remain free. Some of the community also felt as though developers might abuse this system and rely on modders to patch "unfinished" titles, and then reap the financial benefits of those transactions.

Further fire was added to the flame when users reported being banned on Valve's Steam forums for voicing concerns with this new monetization system. All of this eventually led to a petition on Change.org to "Remove the paid content of the Steam Workshop." The body of the petition reads, "Mods should be a free creation. Creations made by people who wish to add to the game so others can also enjoy said creation with the game. We need to unite and reject this act by Valve." The petition ended up getting over 130,000 supporters.

The outcry eventually prompted Valve cofounder Gabe Newell to do damage control on Reddit. In a surprise twist, many of Newell's comments were down-voted, even though the Valve CEO mentioned that many of the concerns voiced by users were warranted.

This eventually led to Valve reversing its role on April 27. Valve's statement read, "We've done this because it's clear we didn't understand exactly what we were doing. We've been shipping many features over the years aimed at allowing community creators to receive a share of the rewards, and in the past, they've been received well. It's obvious now that this case is different."

Valve added, "To help you understand why we thought this was a good idea, our main goals were to allow mod makers the opportunity to work on their mods full-time if they wanted to, and to encourage developers to provide better support to their mod communities. We thought this would result in better mods for everyone, both free and paid… But we underestimated the differences between our previously successful revenue sharing models, and the addition of paid mods to *Skyrim*'s workshop. We understand our own game's communities pretty well, but stepping into an established, years-old modding community in *Skyrim* was probably not the right place to start iterating."

It is worth noting that this controversy has shed light on the idea that modders should be getting compensated for their work. Many fans are urging that Valve implement a donate button for modders. **–JT**

Valve chose to use *Skyrim* to initiate its monetization plan.

> “Thought this would result in better mods for everyone, both free and paid…

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AMD president and CEO Lisa Su.

AMD LEAKS WINDOWS 10 RELEASE DATE

MICROSOFT has put Windows through the ringer during the past year and a half. With Redmond ending support for Windows XP, and a user base that is only half-sold on Windows 8, Windows 10 will be a welcome update, if all goes well. Users who have been chomping at the bit to get their hands on a copy of Windows 10 won't have much longer to wait, if AMD's CEO is correct.

During a Q1 earnings call with investors, AMD's CEO Lisa Su slipped and said that Windows 10 would be released in late July, just in time for back-to-school shoppers. The date Su referred to is a release to manufacturing (RTM) date, where OEMs will receive copies of the OS for pre-installation on products like laptops and pre-built PCs.

"What we also are factoring in is, you know, with the Windows 10 launch at the end of July, we are watching sort of the impact of that on the back-to-school season, and expect that it might have a bit of a delay to the normal back-to-school season inventory build-up," Su said.

Earnings conference call transcripts and earnings reports from publicly traded companies are available to—you guessed it—the public.

Leaks of information about Windows 10 are nothing new, as test builds and screenshots of the OS have made their way to the Internet. Given that the leaks about Windows 10 have generally been good news, the only real damage done is stealing the wind from Microsoft's sails.

Su also hinted that the slowing sales of AMD chips are due to OEMs holding off production until Windows 10 is released.

"I do think OEMs are being somewhat cautious on any inventory build now ahead of Win 10," she said. "As you go forward into the second half of the year, I think, first of all, I think we're all optimistic that Windows 10 can be a catalyst and a driver for the market." **–AC**

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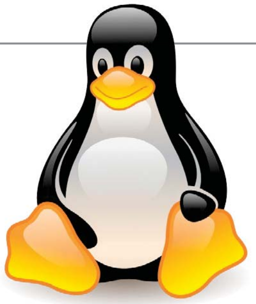


"NEWTUX" BY LARRY EWING

IN THE WORLD OF DEVELOPERS, major new version numbers are usually associated with added features and significant changes. Not so for Linux 4.0. The kernel that's at the heart of Android and Linux desktop and server distributions got a new version number because of the amount of new submitted code and timing, not because of new features.

On LKML.org, Linus Torvalds (the programmer from which the kernel derives its name) wrote, "Feature-wise, 4.0 doesn't have all that much special… So this is very much a 'solid code progress' release."

For users looking forward to new features in the Linux kernel, Torvalds said that 4.1 will be the version to watch. As of writing, a Linux 4.1 release candidate was available for those who want to brave the bleeding edge. **–AC**

BEHOLD: UNCLE SAM, THE VAMPIRE

DHS wants a copy of your crypto keys

AT RSA CONFERENCE, Homeland Security secretary Jeh C. Johnson addressed the crowd of security and crypto geeks to recruit and ask that developers provide DHS with cryptographic private keys. Johnson tipped his hand a bit, revealing that government snooping can be seriously limited by the widespread adoption of encryption. With strong public key encryption, the only way someone can read your data is if they have the key, not unlike a vampire requiring permission to enter a house.

Johnson said he would prefer the government have cordial "front door" access to data, rather than an underhanded software "back door." Minutes before Johnson spoke, his proposal was preemptively dismissed by MIT professor Ron Rivest. For now, it seems, Uncle Sam will find it difficult to get in Silicon Valley's door when his fangs are still dripping with citizens' data. **–AC**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

+ **DEFEAT OF THE EMPIRE**
Faced with FCC regulatory blocks, Comcast withdrew its bid for Time Warner Cable. Cue dancing Ewoks.

+ **DISASTER RELIEF**
Following the massive earthquake in Nepal, Facebook released an app feature that asks users in a disaster area if they're OK.

+ **LENOVO GUTS SUPERFISH**
Lenovo released a Windows recovery image that wipes the Superfish adware off its laptops. Let's hope the company has learned its lesson.

TRAGEDIES

− **SKYLAKE LEAKING**
A Chinese website supposedly got a hold of the SKUs for Intel's new Skylake-S line of desktop CPUs. Intel plans on unveiling them in August.

− **GOODNIGHT, SWEET PRINCE**
Google killed the Nexus 7. The product page simply said: "The Nexus 7 is no longer available."

− **CHINESE SECURITY CRISIS**
Chinese root certificate authority, China NIC, issues a signing certificate that was abused, resulting in a ban from Chrome and Firefox.

Tom Halfhill

FAST FORWARD

Celebrating Moore's Law, More or Less

NOW THAT WE'RE MARKING the 50th anniversary of Moore's Law, everyone is offering opinions about its history and future. Why shouldn't I join the fray? After all, as a microprocessor analyst, I study the famous law's fruits every working day.

Sometimes, especially near anniversaries, reporters call me for a sanity check when doomsayers predict the law is expiring. So what's the truth about Moore's Law?

The holy scripture is an article that Fairchild engineer Gordon Moore wrote in the April 19, 1965 issue of *Electronics* magazine. It was titled: "Cramming More Components Onto Integrated Circuits." It appeared only four years after Fairchild and Texas Instruments introduced the first commercially available planar integrated circuits. Three years after publishing his article, Moore co-founded Intel.

If you look up the article on the Internet, you'll probably be disappointed. Nowhere does it mention a "law" as such—a college professor coined the term "Moore's Law" years later. And you'll have to read very closely to find a precise statement of the law. Even when you find it, you'll be surprised. It says the number of components on an integrated circuit (IC) manufactured at the most economical point on the semiconductor price curve roughly doubles every 12 months.

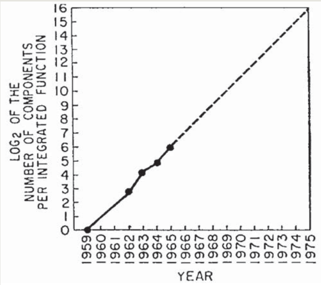
That's probably not what you were expecting. Isn't the doubling period 18 months? And isn't it about transistors? Or clock speeds? Or performance? Nope. To begin with, it's not really a law in the scientific sense. It's an astute observation that's not enforced by any physical properties or the Universe Police.

> We're way behind the curve. However, Moore's Law is so popular that people don't like hearing the truth. I reassure them that it survives in spirit.

In 1965, Moore observed that IC component counts were doubling roughly every 12 months. In 1975, when progress was slowing, Moore stretched the period to 24 months. The widely quoted 18-month cycle is the result of someone else splitting the difference in a dubious attempt to fit the curve to the actual data.

Tinkering with Moore's Law is common, because the curve doesn't fit the actual data. By any measure, we're way behind the curve. Chips haven't been keeping up with the law for many years. However, Moore's Law is so popular that people don't like hearing the truth. So I reassure them that the law survives in spirit, even if we're not living up to its letter.

Another truth is that the law isn't solely about transistors, and it was never about clock speed or performance. It wasn't even about microprocessors, which hadn't been invented when Moore wrote his article in 1965. It was about general IC components, including transistors, capacitors, and resistors. Nowadays, people only count transistors. The omission is partly from ignorance of the law and partly because transistor counts are easier to find than total component counts. On a DRAM chip, every bit cell has one transistor and one capacitor, but how many capacitors are on a processor? Even the chip designers have trouble answering that question.



Gordon Moore's original chart from his 1965 *Electronics* article.

Don't get me wrong. I'm not dissing Moore's Law. It was a brilliant observation that has inspired the semiconductor industry for 50 years. But Moore's 1965 curve is a log-base-two plot that zooms skyward forever.

Now it's 2015. It's time to reverse the term's second word to define what I call "Moore's Wall." That's when the steady progress inevitably stops—something that would be very useful to know, for many reasons. Fame awaits the person who plots *that* curve.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

CyberPower recommends Windows.

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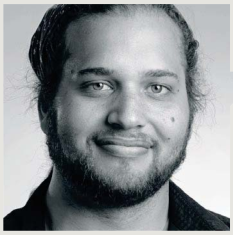


Alex Campbell

OPEN SOURCE

Penguin or the Egg (Pt 1)

DUAL-BOOTING WINDOWS AND LINUX REALLY SUCKS. It's not because I hate Windows, either. It's because I feel it should be unnecessary. It's a half-measure that allows a lot of Linux users to play games or get things done. It doesn't have to be this way, but Linux is faced with a chicken-or-the-egg problem.

Users won't switch to Linux until their apps and games work as expected. But companies like Adobe aren't going to develop native Linux versions of their products unless they have a really good reason (read: they can make money). I must've rewritten this next part 10 times, so I think it's best to come right out and say it: The Linux desktop, for the time being, needs proprietary software to draw users.

The gods were thus angered, and Richard Stallman clenched his fists in rage. I know that sounds crazy coming from an open-source advocate, but hear me out. People dual-boot for the same reason more people don't switch to Linux in the first place: One essential piece of software isn't available in Linux. Never mind that Linux offers a customizable and more secure environment; never mind the monetary cost is zero; they need that software. It's the biggest hurdle I face when it comes to making an argument for my favorite OS.

Like it or not, there are holes in the Linux desktop experience if you don't use proprietary software. Skype and Nvidia's video drivers are prime examples. Right now, you're not going to grow the Linux market share by telling new users, "Sorry, you can only do it the free and open-source way." Business users, designers, and gamers don't want to hear that garbage. They just want to use their machine and complete the tasks they set out to do, preferably without missed sleep and skipped meals from trying to configure Wine properly.

To improve the catalog of available programs, we need to grow a user base that will pay. That means regular users and gamers, not just enthusiasts. If there's one thing I've learned, it's that software companies sure as hell aren't going to release a Linux version unless it makes financial sense. Evernote is a prime example. The company isn't developing a Linux client, despite the howls of desperation from Linux users on its forums.

As users, we can start sending market signals. By surfing the web on Linux, we send the signal to research companies who publish stats based on user agent strings. For gamers, using Steam on Linux sends the same type of signal to game developers.

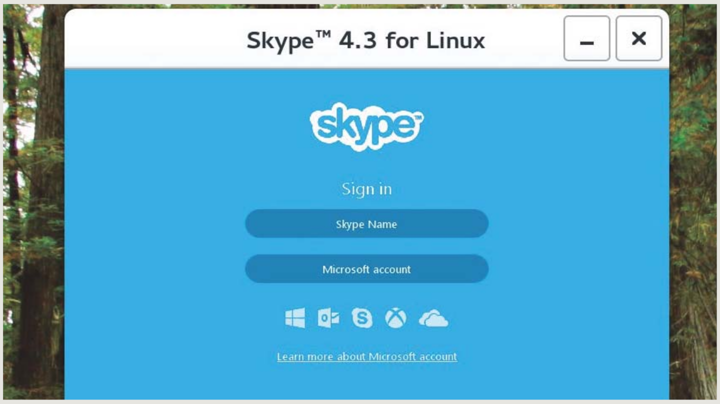
The people who still use Windows XP represent a great opportunity. If they choose to switch, they get to keep their older computer, and gain a faster, more reliable experience for surfing the web, typing documents, and reading email.

There are over 1,000 games on Steam available for Linux, including *Dota 2*, *Bioshock: Infinite*, and all of Valve's titles. That's a good number, but it's a far cry from Steam's total of 11,000. Also, most games are proprietary. People want to be able to play *GTA V*, not just *Tux Racer*. Releasing more titles to Linux helps bring gamers to the OS.

Once there are enough potential customers, hardware and software vendors will have an incentive to support desktop Linux. When big vendors release software for Linux, others will follow. Linux gets better as more users install it.

If I haven't convinced you I'm not stark raving mad, next month I'll discuss how we can get free software to draw users, without the help of proprietary vendors. With luck, Stallman won't strike me down with bolts of lightning before I write it.

Alex Campbell is a Linux geek who enjoys learning about computer security.



Even though I love Pidgin, I still use Microsoft's Skype client on my Arch box.

THE LIST

7 TOP HEAD-MOUNTED DISPLAYS

7

SONY PROJECT MORPHEUS

Sony's VR headset is designed for the company's PlayStation 4 and uses the console's Move controllers.

6

MICROSOFT HOLOLENS

Unlike VR headsets that aim to pull you into the virtual world, Microsoft's AR solution plans to inject holograms into your life.

5

MINDMAZE

This headset is both an AR and VR headset that also happens to track brainwaves.

4

SAMSUNG GEAR VR

Samsung joined Oculus to deliver the first modern, wireless virtual reality solution.

3

RAZER OSVR

As the name implies, Razer's Open Source VR headset aims to provide developers with an open-source VR platform.

2

HTC VIVE

With its unique lighthouse tracking system and 1:1 controls, the Vive is currently our favorite VR system.

Oculus
Crescent Bay Prototype

1

OCULUS RIFT

The Rift raised $2.4 million on Kickstarter and rejuvenated the VR movement.

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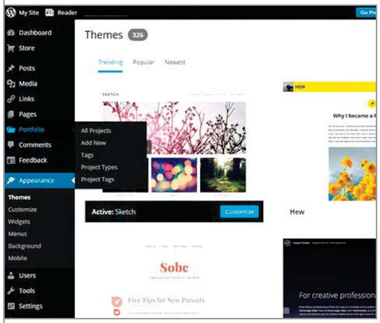
HEAD TO

BY **PAUL LILLY**

Wordpress vs. Squarespace

You've decided to build a website, but don't know where to start. Is that it? You're not alone and you have options. Lots of them, actually. One is to buckle down, learn the ins and outs of HTML, and code your site from scratch. If you don't have the time or gumption for that, there are website builders that streamline the process so that anybody can build the site they're looking for. Two of the more popular are Wordpress and Squarespace. But which is the better option?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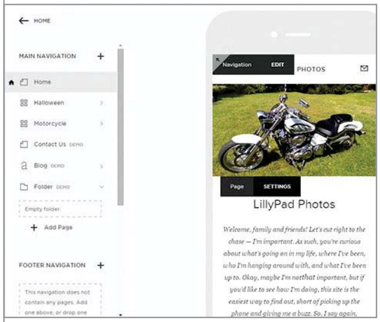
Wordpress is in a league of its own when it comes to the sheer number of themes available.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SETTINGS
LillyPad Photos

Welcome, family and friends! Let's cut right to the chase — I'm important. As such, you're curious about what's going on in my life, where I've been, who I'm hanging around with, and what I've been up to. Okay, maybe I'm notthat important, but if you'd like to see how I'm doing, this site is the easiest way to find out, short of picking up the phone and giving me a buzz. So, I say again,

An intuitive interface makes Squarespace a great option for website-building beginners.

ROUND 1

Price

If you're preparing to leave your first mark on the world wide web, then price is obviously very important. Just remember that, depending on what you're planning, free is often not the best option.

Anyway, to the contenders. Squarespace breaks down its subscription option into three tiers: Personal is $10 per month, or $96 billed annually ($8 per month); Professional is $20 per month, or $192 billed annually ($16 per month); and Business is $30 per month, or $288 billed annually ($24 per month). There's no free tier, though Squarespace does allow you to try any of the options at no cost for 14 days, and without a credit card, which is nice.

All three options come with unlimited storage and bandwidth, and both the Professional and Business subscriptions allow unlimited pages (Personal is limited to 20). Integrated commerce is part of each package too, though you can only sell a single product on the Personal tier. Pro and Business allow for up to 20 products and unlimited products, respectively.

Wordpress also offers three options. They are: Basic, which is free for life; Premium, which is $99 per year; and Business, which is $299 per year.

It's tough to beat free, but if you're serious about building a website, there are several perks to upgrading to the Premium tier, such as more storage (13GB versus 3GB), no ads, the ability to store videos, a custom domain, and advanced customizations. The Business tier ups the ante with over 50 premium themes, e-commerce functionality, unlimited space, and live chat support.

Since Wordpress offers a free tier, it should get the win, right? Not so fast. That's certainly an advantage, but to build more than a glorified blog, the paid tiers are the way to go. And when comparing the paid tiers, both offer good value.

Winner: Tie

ROUND 2

Ease of Use

Building a website can be stressful. Or it can be fun. Part of that depends on your skill level, though the onus here falls on Wordpress and Squarespace to streamline the experience so that you don't feel like the Hulk—smashing your keyboard when things don't turn out the way you want them to.

When you dive into one of the paid options, Wordpress spreads its wings beyond a robust blogging platform and into a bona fide website builder, and though it tries to hold your hand along the way, it's definitely geared more toward users who already have at least some experience building webpages.

Squarespace, on the other hand, is a bit more nurturing to first-time or still-green users. The interface is fairly intuitive, allowing you to hop in and create a relatively professional-looking site without a lot of effort or, just as important, time. And if you do get stuck, there are several helpful video tutorials available.

Winner: Squarespace

HEAD

VS

ROUND 3

Themes and Templates

One of the easiest ways to go about building a website is to take an existing template and tailor it to your specific content and needs. As Squarespace has become more popular, its library of templates has grown. It's also easy to find the right one for you, as they're broken up into categories such as Featured, Businesses, Stores, Porfolios, Personal, Weddings, and Restaurants.

However, there just aren't that many to choose from. Only a few dozen by our count. Wordpress has over 1,700 themes, and if that's not enough, you can hit up the web for even more from various marketplaces. They're not organized as well as Squarespace's, and that might account for something if Squarespace had a few hundred to choose from. But it doesn't. Given the enormous disparity here, Wordpress gets the nod.

Winner: Wordpress

ROUND 4

Flexibility

With Squarespace, it doesn't take a lot of time to build a good-looking website. You sign up and pick a template, then fill in the blanks and/or replace the existing content with your own. Once that's all done, you're basically set.

It takes a bit longer to build a comparable-looking website with Wordpress. However, while the learning curve is slightly steeper, the level of fine-grain control consistently runs deeper with Wordpress.

There are more templates and themes, while there are tens of thousands of plugins to play with. Better yet, it's open source. If you're an experienced website builder or programmer, you can easily get lost in the customizations on offer. And likewise, if you're relatively new to the website-building universe, you'll find that as you grow, there's more you can do in Wordpress—the ceiling isn't just higher, it's pretty much lifted altogether.

Winner: Wordpress

ROUND 5

Support

Wordpress claims it's powering 23 percent of the web. That may or may not be accurate, but there's no disputing its huge popularity. And since it's so popular, there's a vast amount of support out there, both on Wordpress's own forum and in various corners of the Internet. There are video tutorials, forums for help with plugin coding, and guides galore.

The amount of support for Squarespace isn't as robust. Like the service as a whole, however, it's about convenience and ease-of-use. You can browse topics in the Knowledge Base, seek community-sourced answers, view video tutorials, and even go to one-on-one workshops if you're in New York.

We're tempted to call it a draw in this category, and if we revisit the topic in another year or so, perhaps we will. But for now, Wordpress again benefits from being the popular kid on the block—it simply has more resources available.

Winner: Wordpress

And the Winner Is...

If you're new to the world of website building, you're likely to have an easier time with Squarespace. But you're also more likely to one day outgrow what it has to offer.

That's not to say Squarespace isn't a good option, or even a great one, but Wordpress is simply a better all-round service, with more themes and templates. It's also got plugins for nearly every situation, plus an extensive support network. The learning curve is steeper, but the reward for toughing it out with Wordpress is the ability to build a website exactly as you want it, without compromises, which is what makes it our overall winner. ⏻

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> New Builds
> SSD Decisions
> Power Woes

Windows 10 32-bit?

My business requires I use older software that will not run on any 64-bit OS. This program runs very well on Windows 7 when it's installed as a 32-bit OS. Will Windows 10 be available in 32-bit trim for those of us who helped the PC industry get started?

—**Dennis Quicker**

THE DOCTOR RESPONDS: Yes, Dennis. Win10 will be made available as a 32-bit OS. Right now, Microsoft's saying you need 1GB of RAM to run the 32-bit preview version or 2GB for 64-bit. There's another option you might consider, particularly if you're on a machine with lots of memory that isn't getting used by your 32-bit OS. Install the 64-bit build and virtualize your 32-bit workload with Hyper-V. That line-of-business program can run in its own 32-bit world, while the rest of your software enjoys the benefits of a 64-bit environment. Hyper-V is already included as part of Windows 8.1, and it'll be improved in Windows 10. If you want to learn more about it, check out http://bit.ly/1HjQAqF.

The power supply is arguably the most important piece of your PC. Buy a unit able to deliver plenty of current, such as Corsair's CX750.

Time To Upgrade

Hi, your magazine is great! It's actually the first PC-oriented publication that caught my interest (I've been a console gamer since *Pong*). *WoW* got me into the world of PCs, and I'm loving *SWTOR*. Anyway, on to my query. I have an Asus G60VX laptop with an Nvidia GeForce GTX 260M, 4GB of RAM, and Windows 7 64-bit. I bought it at Best Buy for a song back in '09, and it still runs like new. Is there any way for me to upgrade the hardware, or should I just sell it and buy a new one? Thanks, you have a new subscriber! —**Eric Buck**

THE DOCTOR RESPONDS: Talk about a blast from the past, Eric. That system sports a Core 2 Duo processor and its GeForce graphics module includes 1GB of DDR3 memory. While the Doc considers himself an enthusiast and is always eager to swap out mechanical storage for solid-state, in this case it's probably better to enjoy your machine the way it sits and consider saving up for something a little more modern. If you enjoy *The Old Republic* now, on a G92b-based GPU, just imagine jumping forward three generations to something like a GeForce GTX 965M or 970M.

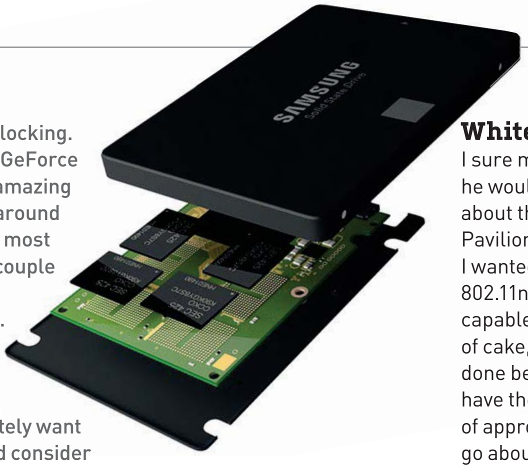
The Do-It-All Build

I'm looking to build a new PC for somewhere between $1,500 and $2,000. It'll mostly be for gaming, but I'll also be compiling software on it. Do you have any recommendations on what to use? I see builds in your magazine all of the time, but they aren't tailored to the way I want to go. —**Viper Locc**

THE DOCTOR RESPONDS: As I'm sure you can imagine, the Doc receives a lot of requests for build help. You'd think they would be easy to answer. But they aren't. Particularly when they're light on important information. Does form factor matter? Do you care more about looks than speed? How much data does this machine need to house? So, the Doc will answer your question as if *he* were building a new PC between $1,500 and $2,000.

Balance is the most important concept to consider as you pick your parts. A bottleneck imposed by any one component will limit performance and detract from an otherwise enjoyable experience. Because you specifically called out software development, Viper, the Doc would start with an Intel Core i7-5820K sporting six cores and 15MB of shared L3 cache. It's an unlocked processor, so you have the opportunity to overclock beyond 4GHz with a good cooler. That CPU needs to drop into an X99-based motherboard. Take your pick—they range from under $200 to over $600, though you don't need to spend big. Asrock, Gigabyte, and MSI all have affordable options the Doc would recommend. Of course, you need a quad-channel DDR4 memory kit to maximize bandwidth, and those get pretty pricey. G.Skill sells four 4GB modules for around $175. They're rated for 2,400 MT/s, though higher data rates are typically easy to

↘ submit your questions to: doctor@maximumpc.com



It'll take next-gen PCIe-attached drives with NVMe support to really push storage performance further.

achieve through overclocking. Next up is graphics. A GeForce GTX 980 will give you amazing performance at up to around 2560x1440 in even the most demanding games. A couple of GeForce GTX 970s should handle 4K well.

The storage subsystem is a matter of personal preference. You definitely want an SSD in there, and I'd consider the 250GB Crucial MX200 to be a baseline for just over $100. Add a 2 or 3TB mechanical disk for less than $100 and you have a fairly capable tiered storage setup able to hold your response-sensitive apps (like games) and user data (like movies and music).

Back all of that hardware up with a high-quality power supply in the 750 to 800W range. Corsair's CX750 would get the job done for around $80. Don't forget a capable cooler for the CPU—closed-loop liquid and big air solutions are equally viable, though you can expect to pay more for the former.

That takes you up to around $1,600, assuming you go the GTX 980 route, leaving a bit of wiggle room to figure out if you need a new chassis, optical drive, operating system, or monitor. If that well-balanced configuration isn't tailored to the way you want to go, you'll need to send the Doc more specific guidance.

SSD Waiting Game

Hello Doctor, I have a new (to me) Toshiba P55-A5312 laptop with a fourth-gen Core i5 processor and 750GB hard drive with 16GB RAM and Windows 8.1 (with Linux as the other OS). It's very quiet except for the disk making noise and running slowly. I have another Toshiba laptop with an older third-generation Core CPU and Samsung 840 Pro inside. It's wonderful. Now I find myself wanting to upgrade the newer notebook's hard drive to an SSD.

Should I wait for the next generation of SSDs to upgrade it, or will Samsung's 850 Pro be more than enough? Can old laptops even take advantage of the speed offered by new M.2 SSDs? I know it's much easier to upgrade a desktop using higher-bandwidth PCIe cards.

—Adam

THE DOCTOR RESPONDS: Don't wait, Adam. From what the Doc can see, Toshiba's P55-A5312 only has a SATA interface. The fastest SSDs available (including the 850 Pro you mentioned) already saturate 6Gb/s links, and that's when you benchmark with a high-end desktop platform. The Core i5-4200U in your machine is one of Intel's low-power 15W parts. It won't push the kind of I/O needed to expose a modern SSD's performance ceiling anyway. But the notebook assuredly would benefit from a move to solid-state storage instead of that 5,400rpm disk.

There's one other thing to keep in mind as you shop for future upgrades: M.2 doesn't necessarily translate to faster storage. The specification facilitates legacy SATA connectivity, which isn't any faster than existing 2.5-inch drives, SATA Express using AHCI, which at least puts the device on a PCI Express link, and SATA Express with NVMe. That last option is where you'll see the next revolution in storage. Unfortunately, the ecosystem isn't quite ready.

The GTX 750 is one of the fastest graphics cards you can buy that doesn't require an auxiliary power input.

Whitelist Woes

I sure miss the Dog. Perhaps he would have warned me about the whitelist on my HP Pavilion DV7 4080US laptop. I wanted to replace its Intel 802.11n card with a newer ac-capable wireless device. Piece of cake, right? But it can't be done because the BIOS doesn't have the card I want in its list of approved options. How do I go about removing that check without bricking my laptop?

—Frank Miller

THE DOCTOR RESPONDS: The Doc is sure that HP has its reasons for limiting the cards you can swap into its laptops (compatibility issues, perhaps?), but he agrees this is an unfortunate approach on an open PC platform. Don't feel singled-out though—other OEMs employ similar strategies to prevent customers from adding untested hardware.

There are ways around the whitelist, though they are by no means trivial. You've likely found the forum threads online that describe how to either add your card's device ID to the whitelist or remove the check process altogether. Many of the folks who try modifying their firmware do damage them in the process. What's more, the Doc cannot find a single example of someone successfully modding the DV7 4080US. Proceed with this one at your own risk.

An Upgrade Gotcha

Dear Doc, I've an aging HP 6000 Pro small form factor PC that my family uses for gaming and other tasks. Though it's a bit long in the tooth, I hope to get another year or so out of it before I shell out the cash for a replacement.

I realize its current specs are holding performance back, but I'm looking for your opinion to gauge whether I should install a few upgrades to try extending its life. Currently, it's running Win7 Pro x64 and has an Intel Core 2 Quad Q9400, 4GB of DDR3 (in a single-channel configuration), a 1TB Hitachi hard drive, GeForce GT 610 with 1GB of DDR3, and a 240W power supply.

I am thinking about buying a Zotac GeForce GTX 750 card with 1GB of GDDR5. It seems to be the fastest low-profile card out there that doesn't need an external power connector. Along with the GPU, I'd also add another 4GB memory module for dual-channel operation. Do you suppose the power supply has enough maximum output to support this setup? Would the upgrade be worthwhile?

—Jason Grant

THE DOCTOR RESPONDS: Your head is definitely in the right place, Jason. Adding a little more graphics horsepower and system memory would have a positive impact on that machine's gaming performance. Nvidia's GeForce GT 610 is rated for 29W, while the GeForce GTX 750 is a 55W card. Your Core 2 Quad is a 95W processor, so it'd be natural to guess that a 240W power supply could handle all of the hardware, even under full load. And the motherboard does in fact support a second 4GB DIMM.

Dig a little deeper into HP's specifications, though. There are two versions of the 6000 Pro—a micro-tower and the small form factor chassis. Both include 16-lane PCIe slots. The former is available with a 320W power supply, while yours, as you know, is limited to 240W. That difference is significant. The micro-tower offers 75W of output on its 16-lane link, while yours can only do 35W. In other words, the GTX 750 likely won't work; the GeForce GT 610 already comes close to maxing out the slot's power. Sorry to be the bearer of bad news.

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Raspberry Pi 2 Model B V1.1
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HDMI

In-home game streaming has truly arrived, but it's a Wild West of new tech. So which device should you buy?

BY JEREMY LAIRD

STREAM MACHINES

STREAMING GAMES from your PC to other devices. It's a crazy idea, right? It is if you really think about the nuts and bolts.

Start with a control input from your client streaming device, whatever that may be. A precision flick of the mouse in reaction to gunfire behind you. That kind of thing. The signal has to be processed by the client box and then sent over your network to the host PC. That PC then processes the input and updates the game state by rendering new 3D frames, calculating some AI, number crunching the audio, and everything else that goes into a modern game engine.

The result of all that is thrown together, encoded into a video stream, and bounced back over your network. The client box then decodes this stream and pumps it out to a display, which itself has image-processing hardware that inevitably adds a little delay.

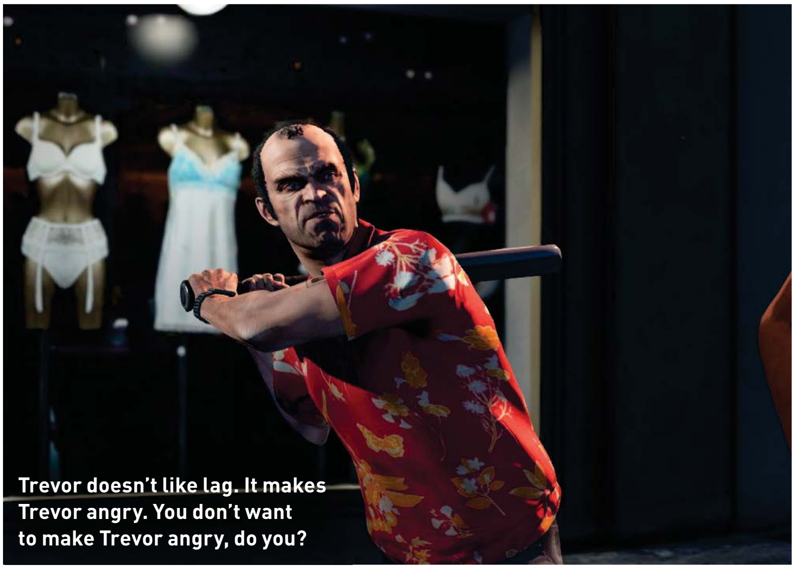
All this has to happen fast enough to be pretty much transparent to you, the end user, with your own wetware doing more than a little processing itself. Move mouse or press controller button, see the screen respond. It has to feel instant. That the latest in-home game-streaming solutions come tantalizingly close to achieving just that is an incredible technical achievement.

How the hell it's all achieved in a passage of time measured in just tens of milliseconds we can barely comprehend. But it is, and no doubt the whole process will only get faster, better, and more responsive. In-home game streaming, then, is a reality. It's not yet ideal for every game or even every gamer. But having a single PC pumping games to multiple devices around your house is one hell of an idea. And there are now a number of ways to do just that. What's really exciting is that you can give it a try for as little as $40.

Welcome, then, to our guide to the state of streaming on the PC, with a heavy emphasis on gaming. That includes everything from insight into the competing streaming platforms to reviews of six of the best streaming boxes available. Let's go.

Last Played
Settings
onLive

Is cloud gaming dead? Maybe, but in-home game streaming is taking off.



Trevor doesn't like lag. It makes Trevor angry. You don't want to make Trevor angry, do you?

First up, let's set some parameters. Streaming means different things to different folks. For some, it can simply mean watching web video.

If that's all you care about, then cheap and cheerful gadgets like Google's Chromecast or an Amazon Fire Stick will get you over the line. Conceptually, those things are streaming simpletons, mere dongles you plug into your HDTV to enable web content on an otherwise dumb device.

The next step up is a fuller-featured streaming box, such as the Roku, which enables a broader range of functionality and apps. It gives you more options and access to more content. But we're talking about the same basic functionality, namely video and music playback.

We, however, want more. Much more. All that media playback stuff is great. But there's a killer streaming app that sets the bar much higher. That's right, it's gaming. Immediately, adding games into the mix means far higher performance expectations and hardware requirements. We're dealing with much more complex streaming devices and services. It would also be pretty nice if our streaming box was a half-decent computing device in its own right. And we want it all for cheap. Otherwise, what's the point? Just buy another PC.

Is that a lot to ask? Maybe. But the hardware guys keep telling us what a great job they're doing in terms of squeezing proper computing down into ever more mini packages, both literally and in terms of price. So why not? Anyway, we all have a rough idea of what goes into basic media streaming. So, let's do a Donald Rumsfeld and tick that off as a known known and address the known unknown that is game streaming. We know we want to do it, but maybe don't realize what goes *into* it. What exactly does game streaming mean, what do you need to get it done, and what are the competing technologies available?

Intel's NUC is a pricey but powerful streaming option.

KEEPING IT LOCAL

We'll start by saying we're not talking about cloud-based game-streaming services delivered to anything with a web browser. With the OnLive cloud gaming service finally and permanently shutting down earlier this year, the future looks shaky for cloud gaming. Instead, we're concerned with in-home streaming from your main PC gaming rig to another device or display, typically but not necessarily, your living room HDTV.

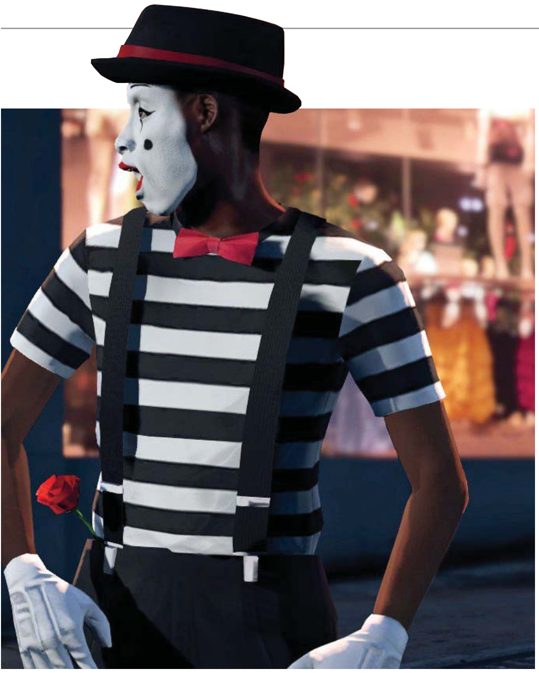
That kind of streaming places far more demands on both hardware and software than mere media streaming. It's also relatively new, making for a veritable Wild West of competing technologies and standards, sometimes complementary, but often quite antagonistic. That's just inevitable when the players that are involved, firms like Nvidia and Valve, are competing to dominate the market.

The default option is Valve's In-Home Streaming tech, which works with basically any graphics card, regardless of branding. If your 3D board is good for gaming on your PC, it's theoretically good enough for In-Home Streaming courtesy of Valve. The main alternative is Nvidia's GeForce Experience plus Shield GameStream platform. But that's a far less flexible option. There's also a third option in the form of the NZXT Doko, which doesn't just take graphics card compatibility out of the equation, but guarantees universal game support, too. Intriguing.

Whatever you go for, however, you're into a whole new class of device compared to mere media steaming. That's largely a consequence of the rigors of game streaming. For video playback, it doesn't matter a great deal if there's a bit of lag between a source device feeding the content and the screen on which you're watching it. So long as the streaming device can decode the video without dropping frames, you're basically golden.

Not so for game streaming. OK, you may not need the latest multi-core CPU or thousands of graphics shaders in a streaming box. Actually, that's the very point of streaming, to enable you to pump gaming action around the house from a single, powerful PC rather than having a pricey gaming rig in every room. But you do need something that can decode a video stream without introducing the great bane of game streaming—you need something powerful enough to minimize lag. You also want a platform that just works, something with broad compatibility with all your games. The question is, how much processing power is enough? While we're at it, how much lag is too much lag? And what is the best game-streaming technology or platform available?

Unfortunately, there are no simple answers. There are no minimum specs to aim for, nor any millisecond metric we can point at, in terms of lag. In our experience, once you get up to around 60ms or so, most people will notice the lag.



Of course, plenty depends on the kind of game you're playing and your subjective sensitivities to lag. Nailing the competition in a hair-trigger shooter can mean that every millisecond matters, making for pretty much the worst candidate for game streaming. A nice-looking strategy game, on the other hand, will be more tolerant of a little lag. Conventional third-person, single-player console ports fall somewhere in between. Either way, if you haven't experienced game streaming before, we think you'll be pleasantly surprised at just how responsive the technology has become.

There's one other request we're making of our streaming boxes. We'd ideally like them to be serviceable, usable computers in their own right. Allowances have to be made for the fact that these are very small and, compared to a full-fat gaming rig, cheap machines. And yet we're still talking about a price measured in many hundreds, at least in most cases. It's a significant investment to make, meaning a little standalone functionality would be nice.

POWER PLAYERS

We don't expect these micro machines to play games themselves. But we are interested in what they're like as computing devices—everything from simple stuff like browsing the web (which can be quite resource-intensive with the latest sexed-up web interfaces) and video playback, to light content creation. Can they cope?

This immediately raises all kinds of tricky questions. How much computing power is just enough? Do you need a full Windows operating system on your streaming box? Will a mobile operating system such as Android get the job done? Perhaps even some freebie open-source Linux action on a super-cheap ARM chip?

Classic Conundrum: AMD or Nvidia?

IT'S THE WAR THAT NEVER ENDS: NVIDIA VERSUS AMD. INEVITABLY, THE LATEST BATTLE INVOLVES GAME STREAMING

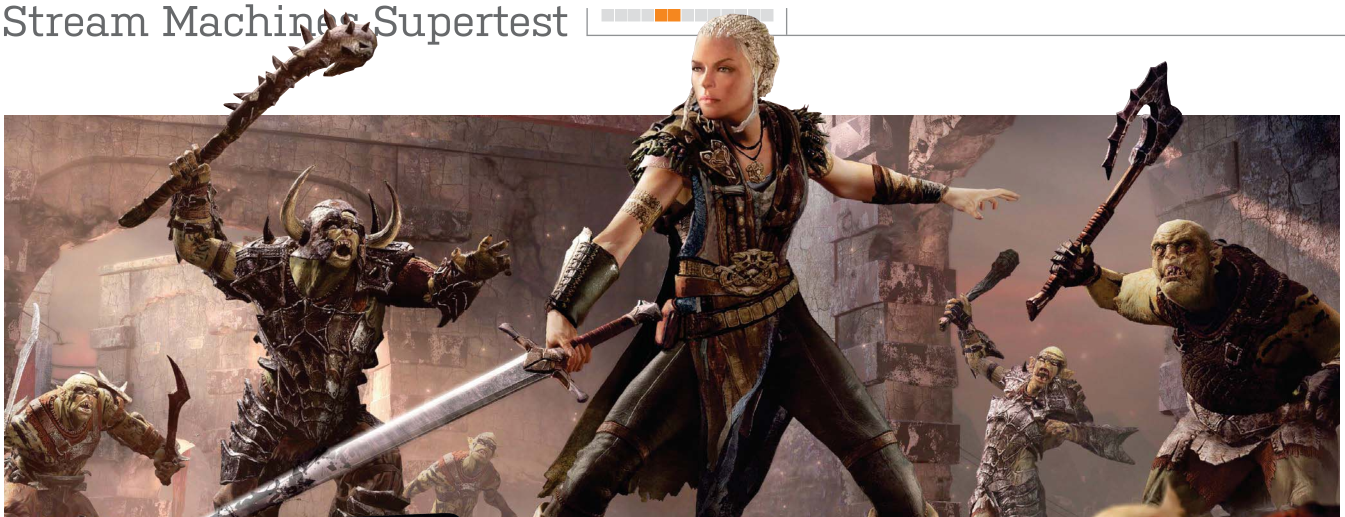
Just like other skirmishes between the two big beasts of the gaming graphics world, streaming finds Nvidia investing in proprietary tech while AMD is plying a more open-source path. For Nvidia, that means making its Shield portable console and Shield tablet the hook on which it hangs game streaming. Add in the GeForce Experience app running on your PC, along with optimizations in Nvidia graphics silicon to improve streaming performance, and you have a total solution known as Nvidia GameStream.

It even includes support for remote streaming of your games from your PC over the Internet as well as features like ShadowPlay, the latter involving optimizations for the capture and conversion of games into video streams. Nvidia argues that restricting its streaming tech to a combination of its own graphics card and a Shield device allows for much more polished performance. And that means less of the biggest killjoy—latency.

On the other hand, Nvidia has no control over your home network, which is clearly critical. Likewise, flexibility when it comes to both graphics cards in your PC and the streaming device itself is obviously desirable.

As for AMD, it doesn't have a complete solution like Nvidia's. Its Gaming Evolved platform can stream for remote viewing, but not for gameplay. Instead, you'll be using Valve's In-Home Streaming tech that's built into the Steam platform. In theory, it's just like Nvidia GameStream. Indeed, Steam is Nvidia GameStream-aware and you'll probably be running in Steam Big Picture mode on your HDTV whichever way you go. So, the basic look and feel will seem the same. But in our experience, Nvidia's end-to-end streaming tech is both better when it comes to lag and also simply more reliable. You get fewer problems with games simply failing to load with GameStream than you do with Valve's In-Home Streaming.

Nvidia's GeForce cards sport streaming-optimized features.



The hardware demands of games like *Shadow of Mordor* up the challenge for game-streaming devices.

Thanks to Limelight, you can use generic Android devices with Nvidia GameStream.

Then there's the minor matter of whether you're looking for a permanent installation alongside your TV, or something more portable. There are an awful lot of options. Luckily, we've gathered together a sextet of devices that should provide pretty much all the answers to those questions.

We've got the money-no-object solution in the form of small form factor PCs with full-on Core processors. The likes of the Intel NUC and MSI Wind *should* deliver something nearing a compromise-free and full-feature Windows experience, together with the fastest, most responsive streaming. Then there's the Intel Atom option, which retains the benefits of a full Windows OS and x86 compatibility with a bazillion apps, plus access to a proper desktop web browsing experience. Atom-based streaming boxes will cost you a lot less. They can also be far smaller and run silently. But at what cost to performance?

NZXT's Doko isn't exactly dumb, but it's also not a standalone device.

You do, of course, have the option of stepping outside the Wintel box. Nvidia's Shield platform is arguably what really got the whole in-home streaming revolution rolling. Nvidia, as ever, has put a lot of work into polishing its GameStream proposition, with a particular emphasis on reducing lag.

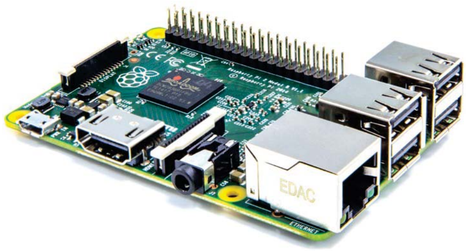
But also in true Nvidia tradition, it's come up with a thoroughly proprietary setup that requires end-to-end Nvidia hardware. You'll need an Nvidia graphics card in your PC and you'll need a Shield console or tablet plugged into your HDTV, or whatever display it is you plan to use. You can't even use a device like, say, a Google Nexus 9, despite it sporting exactly the same Nvidia Tegra K1 processor and also running Android. Nope, sorry folks, it has to be a Shield device. (For more on this, and how it all compares with using AMD graphics, see "Classic Conundrum: AMD or Nvidia?," on page 29.)

SEEING THE LIMELIGHT

Or does it? Actually, it doesn't, but no thanks to Nvidia. Instead, give it up for Limelight, an open-source game-streaming app that plugs right into Nvidia's GeForce Experience interface and allows you to access all its game-streaming goodness, provided you're running a GeForce graphics card.

Even better, Limelight is multi-platform. Versions for Windows, Android, and Linux are available, opening up a whole new world of streaming options, including arguably the most tantalizing of all, the prospect of turning a Raspberry Pi 2 into a powerful gaming PC. Remarkable, given its price.

Raspberry Pi: The ultimate budget streaming box?

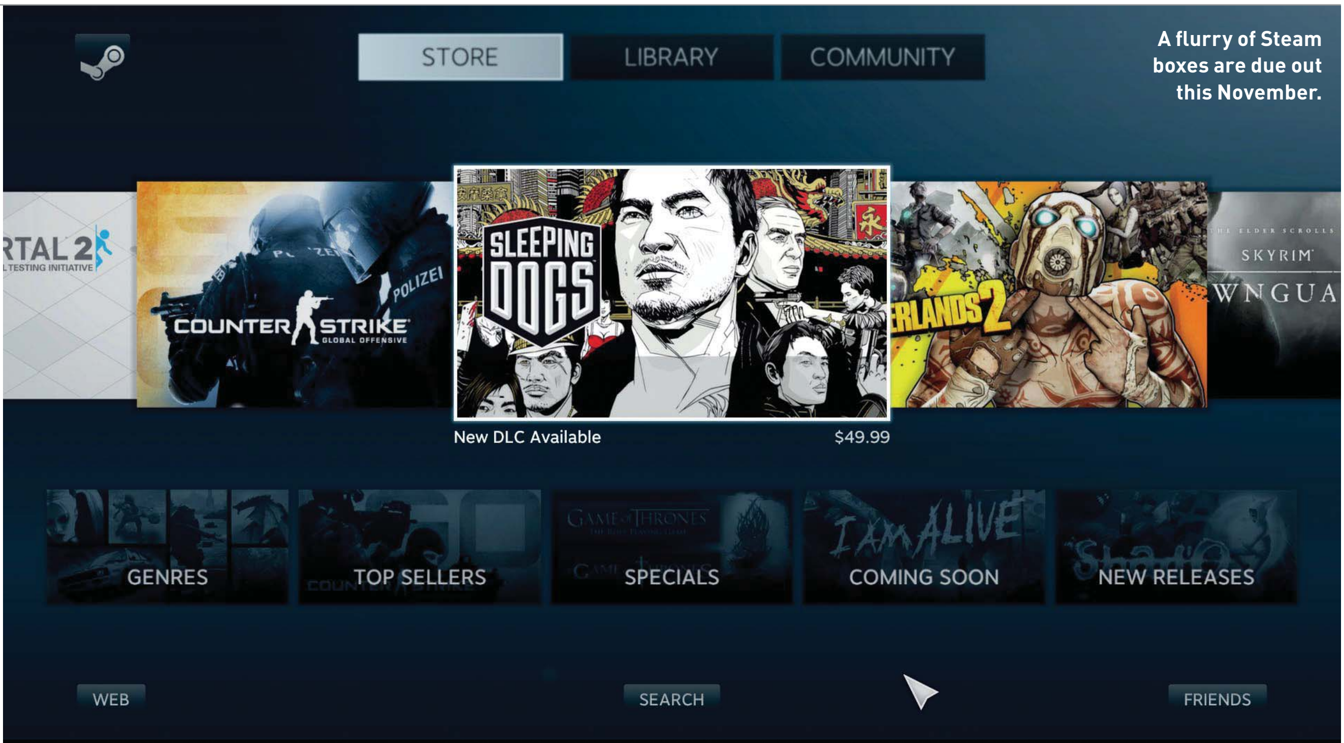


In practice, we've found the Windows version of Limelight to be patchy. The Linux variant, on the other hand, isn't exactly user friendly. It needs a fair bit of setting up and command line expertise, by Windows standards at least. But then it was ever thus for Linux. Limelight for Android is probably the slickest and easiest to use of all. That's handy because it opens up a whole range of options. If you already have a decent Android tablet, for instance, you should be able to get game streaming running without spending a single cent.

Getting back to that Raspberry Pi, it's seen here in its second edition. In many ways, it's hopelessly outgunned, even after an upgrade to a quad-core processor and a gig of RAM. But then it was always going to be. The Pi appears here really to satisfy our curiosity. Is it a genuine game-streaming option? Or is it just a toy, albeit a powerful one, for learning about computing?

The final joker in our streaming pack is the NZXT Doko. It's a bit of a rule breaker due to not really being a computer in its own right. It merely mirrors the output of your PC to another display and has essentially no independent functionality. Disconnect your PC and the Doko drops dead.

The thing is, on paper it does that mirroring in such a clever, full-featured manner, it has us wondering whether all these specialized game-streaming interfaces have got it wrong. Just stream your whole PC, USB ports and all, and forget about game compatibility and the need for specific hardware. Sounds like a no-brainer, eh? These six are not the only streaming boxes out there, of course. But they do cover all the key options. At one end



A flurry of Steam boxes are due out this November.

Steam Or Stream?

VALVE'S STEAM BOX: STILL COMING, BUT WHAT'S THE POINT?

Valve's Steam boxes. Whatever happened to them? A bold vision for the future of PC gaming, the Steam box was supposed to combine a number of new initiatives from Valve, including the Linux-based Steam OS and, indeed, game streaming.

But here we are in mid-2015 and the Steam box proper hasn't really arrived. We're told they're still coming. But should you even care? Arguably, the Steam box is a solution to a problem that doesn't exist.

Valve's Gabe Newell has been quoted bad-mouthing Microsoft, the company he himself used to work for, and its Windows operating system. We're talking about the whole "Windows 8 is a catastrophe" thing.

The temptation is to see the Steam box and Steam OS as something of a personal Newell vendetta against Microsoft. Whether there's any truth in that probably doesn't matter. What does matter is that turning Linux into a proper primary operating system for gaming is a huge task in terms of software and particularly graphics driver support. It's so big that even Valve, the biggest beast in PC gaming software, can't simply snap its fingers and see it happen.

In that context, Steam boxes and the Steam OS make more sense as streaming tech. But then you also have to ask what's wrong with simply running Steam on Windows? The cost of Windows? At least one of the streaming boxes we've tested this month comes with the freebie Bingified version of Windows, which is surely plenty for a mere streaming box. That's not to say Steam OS and indeed Linux itself isn't welcome, but it's more part of the mix than an obvious no-brainer.

of the spectrum, you've got the relatively big money boxes with Intel Core processors. At the other end, it's the preposterously parsimonious Raspberry Pi 2. In between, you've got cheap Atom boxes and tablets.

Of course, once you've picked your stream machine—and in some cases, before—you'll need to take a view on wired versus wireless networking. In an age where wireless comms are assimilating almost everything, game streaming is arguably the final frontier of fixed wires.

No other app you're likely to use is so sensitive to both bandwidth or latency. In theory, the latest Wi-Fi tech has easily enough bandwidth for what amounts to a glorified HD video stream with some control signalling slapped on top. But unlike conventional video streaming, even the slightest connection glitch can be catastrophic for game streaming. Buffering is not an option.

STILL WIRED

All of which means that while wireless streaming can and does work, you need to be realistic about the limitations. Room-to-room streaming can be marginal, for instance. If you're really serious about getting the highest-quality streaming experience, we strongly recommend reacquainting yourself with Ethernet. That's particularly true if you're aiming for the current gold standard in game streaming, which is 1080p at 60fps. That's a fair bit of bandwidth, if you want to keep the image quality tip-top.

Oh, and for the record, our experience with powerline networking is that it's not a great fit with game streaming. For whatever reason, be it protocol overheads or general noise, it tends to introduce too much lag. And that, folks, is the background to game streaming. Time to check out six of the best streaming boxes you can currently buy.

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Intel NUC NUC5i3RYK

A premium option, but at one hell of a price

NO-COMPROMISE COMPUTING in a stupidly small, but beautifully engineered, little box. From day zero, that's been the core proposition from Intel's NUC, or Next Unit of Computing. As it happens, it's been a proposition with which we have, broadly speaking, jived. When it comes to PCs, we like pushing the tech envelope for its own sake, so simple smallness is synonymous with coolness in our book. That's especially true when tiny proportions come with little or no compromise in terms of performance.

There's no denying Intel has engineering clout that goes well beyond most makers of mere barebones PCs, too. Likewise, if anyone knows how to make the most of an Intel Core CPU within the constraints of a very small box, it's surely Intel.

The NUC, however, has always had one major problem. Cost. The starting prices of the various NUC models look tolerable at a glance. But then you calculate the cost of adding memory, a nice, juicy SSD, and a copy of Windows, and suddenly you're looking at $500 minimum. Youch.

That makes for a particularly unflattering comparison with a low-end Intel Core laptop for a similar price. You get everything the NUC offers, plus a screen, an expensive lithium battery, a keyboard, and all that other laptop jazz. Factor in that it has access to its own CPUs at a price nobody else can match, and it's hard to understand Intel's pricing strategy.

In that context, the NUC makes most sense if you try to keep costs in check. So, we've gone for one of the latest models, based on a Core i3 processor. It's still a full-on "Core" CPU, rather than a feeble Atom chip. It's also based on the latest 14nm Broadwell architecture. Admittedly, Broadwell doesn't bring much by way of new CPU hotness. It's a die shrink, primarily. But it does have some much improved graphical prowess, which has always been the NUC's main weakness.

GRAPHICS GRUNT

For the record, this particular NUC is a physical dead ringer for previous efforts, but sports a Broadwell Core i3-5010U chip. That means dual-core and a clock speed of 2.1GHz, but no Turbo mode. That said, it does have Hyper-Threading. More importantly, it also packs 24 Broadwell-style graphics EUs, the net result of which is 3D performance not far off that of the top Iris Pro graphics from the old Haswell line. What's more, thanks to its DisplayPort output, you'll have no problem driving super high-res monitors. Nice.

Anyway, as a mere streaming box, the NUC is probably overkill. There's performance to spare. The problem is that it's not an officially sanctioned Nvidia bit of kit, so in Windows it'll be Steam's slightly flaky In-Home Streaming that you'll be leaning on, rather than Nvidia GameStream. Limelight, of course, gives you unofficial access to the more reliable Nvidia streaming tech. But Limelight works far better on Android and Linux currently, so you're then weighing up the pros and cons of dumping Windows for Linux. Tricky.

As a straight PC, the NUC delivers easily the best experience here. No surprise given its specs and the fact we slung in a high performance SSD. You simply don't have to worry about basic things like browser performance or HD video decode. It just works. In that sense, it's a gale-force performer compared to the light breeze from MSI's ostensibly similar Wind, and an object lesson in the importance of solid-state storage for overall performance.

Ultimately, the NUC is sub-optimal as a streaming box. It's very quick, but to the point of overkill for this application. Like every NUC so far, it's also pricey and presents a tricky OS conundrum given current platform options. You can spend less and get both better streaming support and broader functionality elsewhere.

SPECIFICATIONS

CPU	Intel Core i3 i3-5010U
Storage	N/A
Networking	Ethernet; Wi-Fi (802.11ac)

VERDICT 7

Intel NUC NUC5i3RYK

➕ **ROLLS ROYCE** Proper PC performance from Core i3 chip; premium engineering; plenty of ports.

➖ **PRICEY CHOICE** Way too expensive; not great for hooking into the Nvidia GameStream tech.

$300 (barebones), www.intel.com

MSI Wind Box DC111

A small but proper streaming PC for peanuts?

THE LORD GIVETH. And yet he also taketh. So it is with Intel's NUC, which gives you a lovely, compromise-free computing experience, but saunters off with most of your money. Fully built, it's horrendously expensive for what amounts to a low-end laptop in a box. Without a screen.

The NUC also leaves the door wide open for an alternative proper-PC proposition that puts Intel's full-fat Core CPU architecture into a tiny box, without also obliterating your bank account. It's a door that MSI is all too happy to step through with the Wind Box. What we're dealing with here is an evidently full-function PC, complete with an Intel Core-architecture CPU, a Windows OS install, system memory, and mass storage. It's all squeezed into a tiny box. And it's yours for just $320. That's way below the typical price of a fully built Intel NUC. Remarkable.

Inevitably, the cost cutting does bring compromises. As Core-based CPUs go, the Wind's Celeron 1037U chip is about as lowly as they come and clocks in at a mere 1.8GHz. It also lacks Hyper-Threading. And yet it remains a proper dual-core chip from Intel's 22nm Haswell family. That makes it pretty much an order of magnitude more powerful, in pure CPU terms, than anything else here bar the Core i3 in the NUC.

If you're interested in a scientific measure of exactly how the Wind's budget CPU stacks up, the Celeron 1037U scores 115 points in Cinebench R15's multithreaded test to the NUC i3's 218 points. A big gap, but then the Core i3 does have Hyper-Threading. The single-threaded performance delta, on the other hand, is a lot tighter.

Our review model also comes with 4GB of RAM and a 500GB hard drive. It's that latter component that probably proves to be the Wind's downfall. It's a conventional magnetic drive, which is bad enough in this age of solid-state storage. Even worse, to fit into the Wind's compact enclosure, it's inevitably a compact 2.5-inch item, making performance even more patchy.

The net result is the Wind feels frustratingly laggy when disk access is determining performance. In practice, that's a lot of the time and means the Wind makes for a disappointing all-round performer. The fact MSI disables all the visual bells and whistles in Windows 8 is a bit of a giveaway. Performance is marginal.

STORAGE STRANGENESS

As it happens, MSI also offers a version of the Wind with a 120GB SSD as an alternative, for the very same price. So we whacked in an SSD of our own (a pleasingly simple procedure, if you're wondering) and discovered that performance is much improved. For reasons we can't fathom, even decoding web video from YouTube is smoother with an SSD installed.

As a streaming box, the news is generally better. Over Ethernet, which is the only networking option as standard, since Wi-Fi isn't included, it's responsive and registers around 40 to 50ms of lag in Valve's In-Home Streaming metrics, even at the highest quality settings. That, incidentally, translates into 1080p gaming that looks very close to 1080p being rendered natively on a PC. Running next to each other, you have to look pretty closely to pick the host PC from the streaming box based purely on visual quality.

As ever, the limitations of Windows-based streaming boxes apply. In-Home Streaming with Steam can be patchy in terms of game support. It could, therefore, be worth switching to Linux for the more optimal streaming experience courtesy of Limelight and Nvidia GameStream.

But most of all, we'd recommend turning your nose up at this 500GB magnetic Wind and going with the sweeter-smelling 120GB solid-state alternative. It's no more expensive, but with an SSD, the Wind's true potential is unleashed.

SPECIFICATIONS

CPU	Intel Celeron 1037U
Storage	500GB magnetic drive
Networking	10/100/1000 Ethernet

VERDICT
7

MSI Wind Box DC111

+ GALE FORCE Full-feature PC in a small box; CPU has Intel Core architecture; very attractive pricing.

− DEAD CALM Magnetic hard drive crushes responsiveness (SSD available for the same price); no wireless as standard.

$320, www.msi.com

Nvidia Shield

Try some slick streaming-optimized tablet schtick

IT'S HARD TO KEEP UP with Nvidia at times. On paper, its core proposition is pretty simple—make the best graphics cards on planet Earth. But so relentless is its quest for utter domination that the number of Nvidia's spin-off technologies is becoming borderline bewildering.

It started with SLI multi-GPU tech and expanded to stereoscopic GeForce 3D, then took in the adaptive refresh hotness known as G-Sync, and spanned out to ultramobile with the Tegra chip, while also including things like the auto-optimization software that is GeForce Experience.

There's also the minor matter of two Android-based gaming portables in the form of the slightly whacky Shield console, and latterly the Shield tablet. Phew. As if that wasn't enough, Nvidia has its own game-streaming tech in cloud form (GRID) and in-home streaming (GameStream).

Anyway, the point of this roll call is not just to sing Nvidia's praises. No, the point is that in-home game streaming is an example of how Nvidia's many fingers in many pies sometimes come together rather serendipitously.

Here's why. Nvidia's streaming tech hooks into multiple parts of its product range. The GPUs provide the 3D rendering on the host PC, but also have hardware optimizations under the ShadowPlay moniker that improve the initial encode of your game stream. In turn, the Shield provides the Nvidia-honed streaming targets, while GeForce Experience delivers a platform for orchestrating the whole GameStream process, which, incidentally, plays nicely with Valve's Steam platform.

What you've got, then, is an end-to-end Nvidia take on streaming, which on the one hand makes it the best optimized option of the lot, but on the other demands you splash out on a whole lot of Nvidia gear.

When it comes to the tablet, that may not be a bad thing. It's a distinctly decent 8-inch Android tablet in its own right and comes complete with Nvidia's latest and greatest Tegra K1 chip. You know, the one with those special Nvidia-designed Denver cores and 192 graphics shaders, albeit from the outmoded Kepler GPU architecture.

SMOOTH OPERATOR

The screen is a quality IPS affair, the build quality is pleasing, and Nvidia has been quick to release Android OS updates. Is it the best on the market simply as a tablet? Probably not. But if you want a generic Android tablet and you're an avid PC gamer, its PC-friendly features make the Shield an obvious choice.

As a streaming device, it's up there with the best. Nvidia leads the way in minimizing lag and ensuring game compatibility. In our testing, everything loaded without a glitch and ran smoothly in terms of streaming games to the Shield itself. Levels of lag were as low as it gets. That said, we still want better. Online shooters still aren't really viable.

Hooking the Shield up to an HDTV and running it in console mode is simple, and the Shield Hub, which gives access to the main game-streaming features, is a typically slick affair. If there's a potential snag, it involves networking. By default, you'll be streaming to the Shield over Wi-Fi.

Depending on the network quality, wireless may be fine. In our testing, which involved short-range and same-room wireless connectivity, and what probably amounts to ideal conditions, we still had the occasional problem with the network dropping out. Needless to say, that doesn't need to happen much before it's annoying.

Of course, it's possible to hook up the Shield to a wired network with Ethernet over USB. But it's just possible that the ideal network solution for your Shield could need some initial massaging. Oh, and remember. You'll need to pay extra for Nvidia's wireless gamepad controller.

SPECIFICATIONS

CPU	Nvidia Tegra K1
Storage	16GB
Networking	Wi-Fi (802.11n)

VERDICT 9

Nvidia Shield

+ POINT GUARD Nice Android tablet in own right; all those Nvidia streaming optimizations; lag as low as it gets; great software.

− ON THE BENCH Expensive; not ideal for wired networking; streaming performance over wireless is still patchy.

$300, www.nvidia.com

NZXT Doko

A brilliant little streaming box, in theory...

STRICTLY SPEAKING, NZXT's Doko ought to fall at the first hurdle. It's not actually a computing device in its own right. It's just a dumb mirroring box. Unshackle it from the host PC, and it effectively drops dead.

But hang on. Our numero uno concern is game streaming, and that lifts the Doko from dodo status to something more interesting. Here's a box that promises to banish compatibility concerns. With the Doko, it doesn't matter what graphics card you've got. It doesn't matter what game you're trying to play. If it works on the host PC, it'll work on the Doko. The end.

If that sounds great, it gets better. The Doko is cheap. Not quite crazy cheap like the Raspberry Pi. But surely affordable enough for almost anyone interested in streaming. So what exactly is the Doko? It's a thin client box that plugs into displays via HDMI and into your PC via an Ethernet network. On the host PC in question, you install some simple streaming software.

NZXT has partnered with MirrorOp for the software side of things. Well established in streaming, MirrorOp offers software to throw content from PCs and Macs to phones, tablets, or another PC.

Specs-wise, the Doko is so simple in principle the details hardly seem to matter. For the record, there's an ARM 11 chip complete with a dedicated 1080p decode engine, which sounds ideal for the job. But there is one number that will catch your eye and sow a few seeds of doubt. The Doko tops out at 1080p, which is fine. But it also won't go beyond 30Hz at that resolution, which is not so fine. Odds are any HDTV you're plugging into won't exceed 60Hz on an HDMI interface. So we're not going to penalize the Doko for lacking 120Hz-plus hotness. But 30Hz? For PC gaming? Really?

Hold that thought for a moment, because first impressions are pretty positive. Initial setup is super simple and startlingly swift. You're up and streaming over Ethernet within minutes. The only possible snag is that NZXT has made downloading the Doko software for the host PC trickier than need be. It doesn't appear on the Doko support page on NZXT's website. Instead you must go to the dedicated Doko site.

LAG'S A DRAG

Still, it's really hard not to be impressed at just how rapidly the Doko picks up your PC on the networks and then, pow, there's the desktop from your PC, streamed in remarkably good quality. The levels of lag initially feel good, too. Since it doesn't use any of the dedicated game-streaming techs, you can't use the likes of Valve's In-Home Streaming to measure the lag. But you can do ye olde side-by-side virtual stopwatch trick and take a single picture of the host PC and the streaming screen to measure the overall lag.

The answer is around 40 to 50 milliseconds, and so about the same as PVA LCD monitors from the bad old days when we used to regularly test input lag with the same method. Bad for a monitor, but much more tolerable for a streaming solution, then? What's more, the Doko effectively streams USB connectivity over the network, too, allowing you to plug in not only peripherals like mice and keyboards, but mass storage devices, too. That's caught your attention, eh?

Unfortunately, it's all downhilll from there. The actual gaming experience is very disappointing and goes to show the limitations of benchmarks. Gaming on the Doko feels horribly laggy, whatever our camera says about the precise latency. Tolerance to lag varies, but for us, it's so sluggish we just don't want to game on it.

All of which makes that 30Hz limitation somewhat academic. Ditto, as it happens, the compatibility advantages. By all means bag a Doko for general streaming duties. But we just can't see anyone enjoying gaming with this level of lag.

SPECIFICATIONS

CPU	WonderMedia 8750
Storage	N/A
Networking	10/100/1000 Ethernet

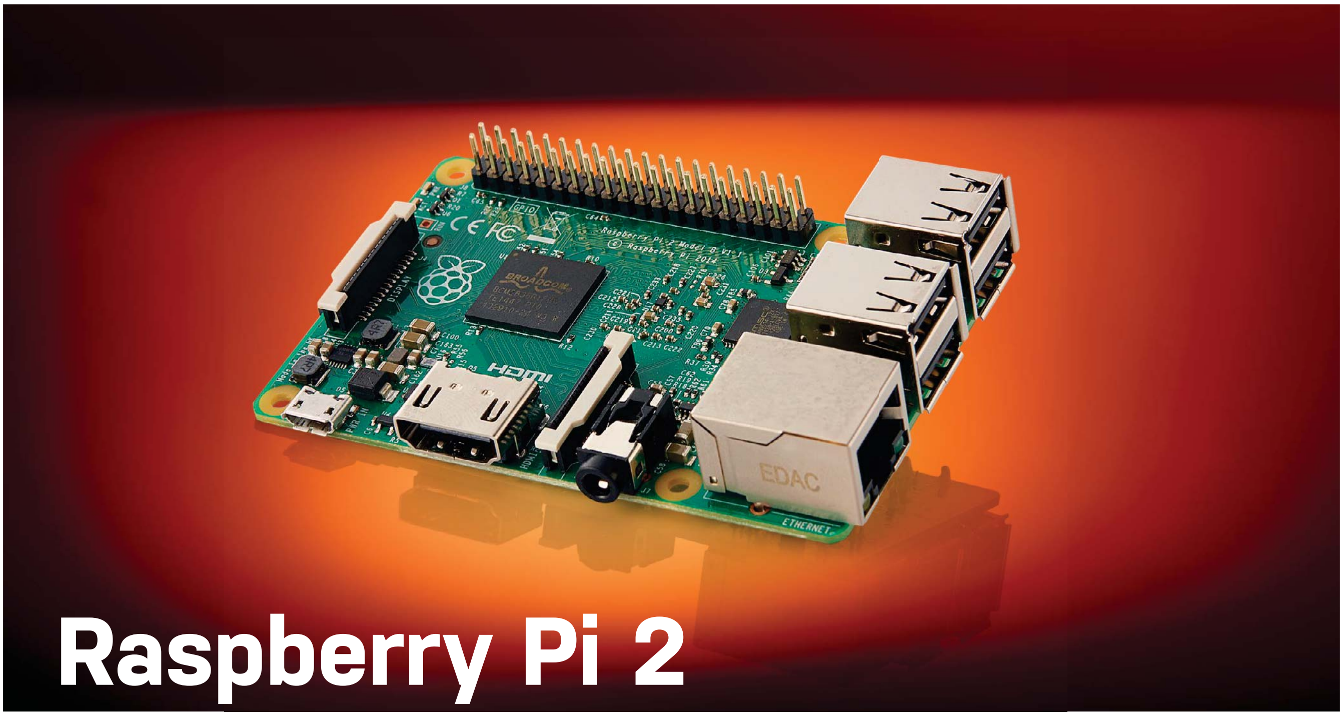
VERDICT
4

NZXT Doko

+ DOKO A total streaming solution; comprehensive graphics and game compatibility; super easy setup.

− DODO Lag, lag, lag; USB functionality is unreliable; did we mention how bad the lag is?

$100, doko.nzxt.com



Raspberry Pi 2

Get a taste of game streaming with the sweet little Pi

WHAT'S THIS? Some kind of comedy entry? A $40 toy with an ancient ARM processor? This thing can't even play Flash video, ferchrissake. Surely, then, the Raspberry Pi has no business being considered for any even remotely performance-critical application. Even this second-generation Pi with its comprehensive upgrades. Game streaming, after all, is nothing if not performance sensitive.

To be clear, you don't actually need your streaming box to be a 3D pixel pumper par excellence in its own right. But you definitely do need something that can decode video stream with absolutely minimal latency. What are the odds that the Pi can do that?

Those upgrades might help. Roughly three years since the Pi first popped up, this second-gen barebones board has arrived. True to the ethos of the original, you get nothing but the board. Not even the micro-USB cable you'll need to power it up.

That's fine by us, especially when you factor in the jump from single-core to quad-core. Each core is more powerful than before, the net result of which is a beefy 6x boost in raw CPU performance. Nice. But hang on. We're still talking about ancient ARM Cortex-A7 cores, which are a long way off the cutting edge for ARM processors, much less being even remotely competitive with even an entry-level Intel Core CPU.

Elsewhere, you now get 1GB of RAM along with Ethernet, HDMI, four USB ports, a MicroSD slot, and a few other bits and pieces. As before, it's simply a delightful little thing for the money. Just watching it boot is fun, as you marvel at a full Linux OS complete with a decent-looking GUI pop up. It's a reminder of the simpler, purer age of computing enthusiasm.

Then you fire up the Limelight app and things get even more impressive. Well, we say fire up. For some, the relative complexity of the command line shenanigans required to get it running will feel a bit like hand coding the streaming interface. It was even enough to have our resident Linux expert scratching his head, if only momentarily.

CHEAP AND CHEERFUL

Anyway, courtesy of Limelight, streaming games from an Nvidia PC works surprisingly, perhaps even astonishingly, well. Watching something seriously sexy like *Shadow of Mordor* being rendered, in a manner of speaking, on the Pi, is enough to make you laugh out loud. And draw a crowd in the office. You just don't expect something so cutting edge to work on such a modest computing platform.

Get the settings right and it doesn't just look good, it's actually playable, too. OK, keeping lag down at a tolerable level means limiting the stream to 720p. Step up to 1080p at 30Hz and the lag becomes just a little too excessive, even for casual gaming. At 1080p and 60Hz, it's getting on for about a full second. Not good. Oh, and of course, as standard you're limited to streaming over a wired Ethernet network.

Slightly less impressive is the broader computing experience, if you're judging the Pi as a secondary PC. Basic web browsing, for instance, is just about doable. But Flash video isn't supported and generally the experience feels quite limited. Not hugely relevant for the Pi's intended target market. But problematical in this context.

Anyway, the bottom line is that the Pi, even in this much upgraded form, isn't exactly a killer streaming device. And nor is it a great computing device in a conventional sense. On the other hand, it's preposterously cheap and a fun thing to have.

So, it actually makes sense as a toe dipper into game streaming. Grab one, give it a go, and find out what game streaming is all about. When you're done experimenting, you've still got a fun little toy, whether you then step up to a proper streaming box or decide it's not your bag.

SPECIFICATIONS

CPU	Quad-core Broadcom 2836 ARM Cortex-A7
Storage	N/A
Networking	10/100 Ethernet

VERDICT

7

Raspberry Pi 2

+ **TASTY PIE** Silly cheap; surprisingly powerful as a simple streaming box; just a fun toy all round for experimenting.

– **AIN'T GONNA FLY** Linux still not that friendly for noobies; not a great all-round computing experience; Flash unsupported.

$40, www.raspberrypi.org

Zotac ZBOX Pico PI320

A different kind of pocket PC

ONE DAY, the distinction between mobile and desktop computing won't have any meaning. The wizards of chip production will have shrunk transistors to such tiny proportions that packing almost any quantity of compute power into almost any device, no matter how small, will be a given.

We're not there yet, of course. Not by a long shot. Indeed, as transistors approach the very size of an atom, it's looking like we're getting close to the limits of what current computer chip tech can deliver. If there are doubts over further progress, the obvious question is just how close to full desktop performance the latest ultramobile PC processors have come.

Enter the preposterously pocket-sized Pico, this supertest's representative for the Intel Atom ultramobile processor. In 2008, the end-game for Atom seemed to be smartphones. But it hasn't played out that way, and here in 2015, it's cheap laptops, tablets, and desktops that fit the Atom feature set best. The Atom is the measure of mobility for x86 processors.

The ZBOX gets the latest Bay Trail version of Atom with no fewer than four cores. Bay Trail includes Intel's Silvermont CPU cores, which are significant for being the first actual update of the Atom core since 2008. All previous Atoms used the same Bonnell core, which was actually designed back in 2004. Yikes.

Anyway, those fancy Silvermont cores run at speeds of up to 1.83GHz in the ZBOX, and they're complemented by 2GB of 1,333MHz DDR3 memory and Intel's own HD Graphics in Gen 7 trim. For the record, you'd better not get too excited about the prospects of 3D gaming natively on the latter. For Bay Trail, you get just four HD graphics execution units. The graphics in Intel's current Core processors offer up to 48 execution units. Even then, it's pretty pathetic compared with any half-decent dedicated graphics card.

The remainder of the ZBOX's spec includes Ethernet, N-spec Wi-Fi, Bluetooth, HDMI, and three USB 2.0 ports. Plus, it's all running Windows 8.1 with Bing. It is, in other words, a proper Windows PC. But here's the kicker. That Windows OS is installed on an embedded eMMC flash memory card, with Zotac offering both 32GB and 64GB SKUs.

DOUBLE DISAPPOINTMENT

Overall, the picture is of a PC with some significant technical compromises, one of the most obvious being the mere 2GB of system memory. But that's the price you have to pay to create something so very tiny. And we are talking truly tiny. At 115mm by 66mm, and 19mm thick, this thing will genuinely fit in your pocket. It'll also sit neatly on the rear of a PC monitor courtesy of VESA mounts. But is it any good as firstly a PC and secondly a streaming box?

As a PC, there's no getting around it. It's a disappointment. The web browsing experience is particularly poor, with the ZBOX unable to decode streaming HD video from sources like YouTube smoothly. It's actually a little mystifying given the ZBOX's CPU utilization is pretty modest during this kind of video decode. But some part of the platform is really slowing things down.

Unfortunately, the picture for streaming isn't much better. Steam's Big Picture Mode is ugly on the ZBOX thanks to catastrophic levels of lag. Once you're in-game, however, things are much improved. But with the Windows version of Limelight currently a bit half-baked, you're annoyingly limited to Steam's In-Home Streaming tech, and that makes for very patchy reliability, with as many games failing to launch as actually booting properly.

It's a pity, because the ZBOX Pico is a lovely little gadget right down to the calming glow of its ring-shaped power light. But whether it's as a conventional PC or a dedicated streaming box, it's a disappointing performer. It's cheap alright. But it ain't cheap enough.

SPECIFICATIONS

CPU	Intel Atom Z3735F
Storage	32GB eMMC flash
Networking	10/100 Ethernet, Wi-Fi (802.11n)

VERDICT 6

Zotac ZBOX Pico PI320

+ NUCLEAR POWER Full-function PC in a stupid-small box; full x86 compatibility; latest Atom CPU cores.

− NUCLEAR WASTE Overall platform performance is poor; catastrophic lag in Steam Big Picture interface.

$169, www.zotac.com

And the winner is ...

Nvidia Shield

SUPERTESTS OF THE LATEST GADGETS for your PC are always interesting, even if that just means getting to grips with the latest technologies and releases. But when it comes to game streaming, there's a whole lot more to learn.

Together, the six devices gathered here give you a pretty comprehensive overview of both the different device options and the current state of game-streaming tech on the PC. We're happy to report the news is mostly good. Currently, the key challenges for game streaming go something like this. First, you want that stream to keep going and not chuck you out the game. Second, you need as little lag as possible.

ROOM FOR IMPROVEMENT

Progress has been made on both counts. Use a wired network, along with hooking into Nvidia's GameStream interface either natively or via the open-source Limelight tool, and you'll find few problems with either initial game compatibility or in-game reliability. Lag levels, meanwhile, continue to gradually improve. When you think about all the steps that go into creating a game stream and pumping it from your PC to a target device, it's all very impressive.

On the other hand, streaming over wireless networks still remains a patchy affair. Given that Wi-Fi is so much more convenient than Ethernet, that's a pity, but understandable. Likewise, while lag levels on the best hardware are impressive, there's still plenty of work to do if streaming is going to be suitable for all game types. As already mentioned, there's still some way to go before latencies are low enough for online shooters. So, an overall verdict? Streaming is rapidly maturing but still remains in the early-adopter phase. That fact should inform your choice if you do want in on the action.

EARLY FALLERS

Of our six candidates, the NZXT Doko is first for unceremonious defenestration. It's a brilliant idea, simply streaming over the whole PC, USB ports and all. But the lag levels render it irrelevant in a gaming context, which means it isn't for us.

Next for the chop is the Zotac ZBOX Pico. In many ways it seems the ideal streaming device. Tiny, cheap, but still a proper x86 Windows box, it pushes all our buttons on paper. In practice, unfortunately, poor performance by pretty much every metric kills it stone dead.

From here on in, the options get a lot more interesting. For anyone unsure about game streaming, the nimble little Raspberry Pi 2 is a great way to give it a try without truly committing. It's so cheap it may as well be free, and you'll have a fun little toy to play with, whatever you make of the game-streaming thing.

Next up are what you might call the two proper PCs, Intel's NUC and the MSI Wind. The NUC remains as appealing as ever as a technical achievement. But it also remains as expensive as ever. Moreover, all the NUC's power doesn't really deliver any major advantages when it comes to streaming performance.

TABLET TRIUMPH

As for the MSI Wind, it could have been a contender for top honors were it not for that laggardly magnetic hard drive spoiling everything. So, yup, you probably guessed it. Nvidia's Shield tablet is our overall streaming weapon of choice. It's a decent Android tablet in its own right, but also delivers the best overall streaming experience currently available, with the sole caveat that achieving an ideal network setup with a Shield may take a little work. It ain't cheap. But it's worth it. ⏻

> “When you think about all the steps that go into creating a game stream, it's all very impressive.”

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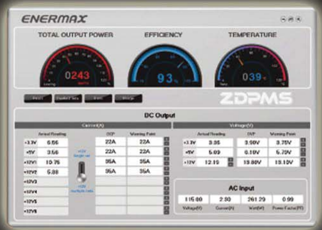
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The proprietary ZDPMS software allows user to read
the real-time PSU power consumption, efficiency
and internal temperature. The DC output current, voltage
protection warning points and 12V rail(s) can also
be manually configured.

Fanless and Full Power @ 40°C

Fanless design creates a 0 dBA soundless
operation for home theater/noise sensitive systems
with a full power output @ 40°C/104°F ambient.

80 PLUS® PLATINUM

BUILD IT!

YOUR PERFECT PC

Don't put off building your perfect PC any longer! We show you how to pick the right components, piece it all together, and optimize it for maximum enjoyment **BY THE MAXIMUM PC STAFF**

There are two schools of thought when it comes to equipping yourself with a killer new PC. The first is the more risk-averse, recommending that you pay someone else to do all the hard work for you. That way you're delivered a machine that simply works, the moment you ease it from the box.

The second school considers such behavior sacrilegious. Instead, it's forever faithful to its central belief: Thou shalt always build, no matter what. Here on *Maximum PC*, we tend to advocate for the second camp, but we're wise enough to understand that the market has changed a lot in recent years, and working out whether you should build or buy isn't quite as straightforward as it once was.

Traditionally, self-builds had the advantage of being the cheaper option. The difference may have been slight in some cases, but it was generally always there. Even if a system builder had exactly the components you wanted to build your own machine with, you could generally shop around and pick up the exact same parts for less and save a pretty penny by putting it together yourself. Many of the more expensive systems still have the potential for decent savings, but that margin has disappeared in some of the machines we've looked at recently, especially at the cheaper end of the market.

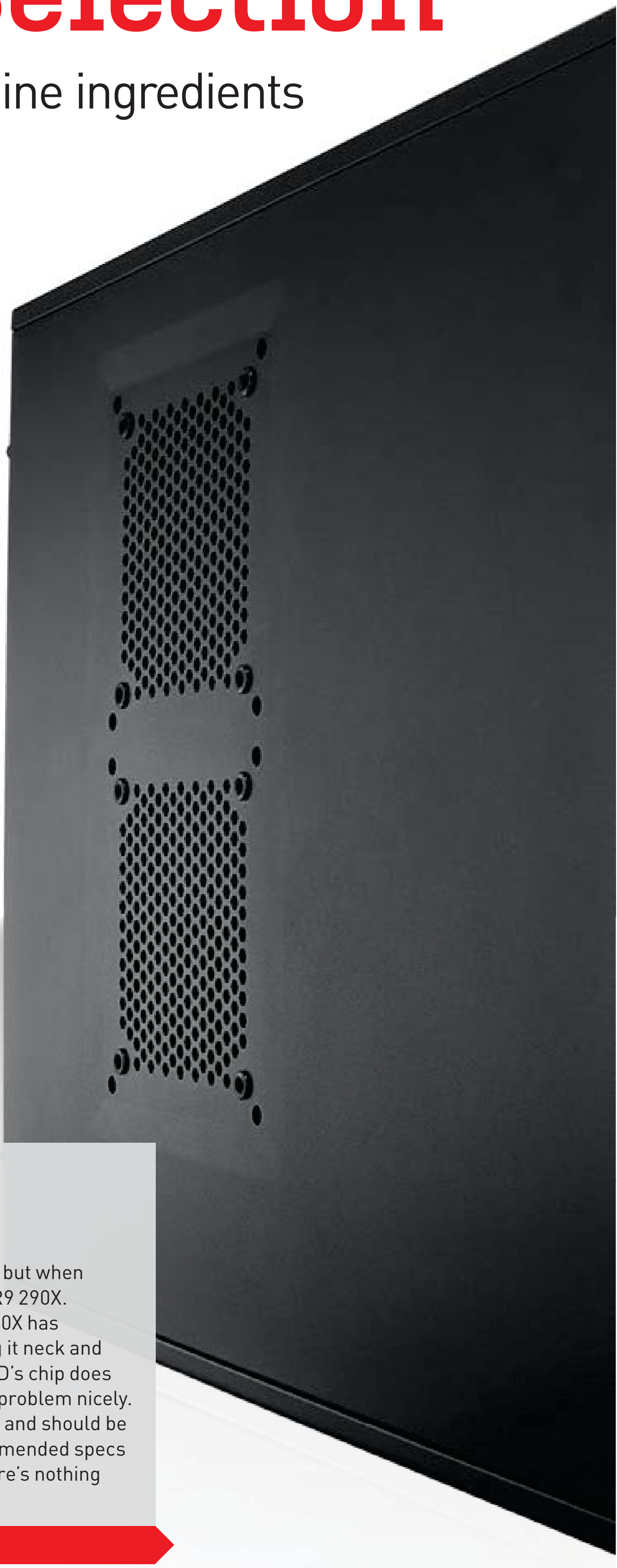
This leaves the main reason to build as making sure you don't waste your money on components you don't really need. You get to spend the cash where it matters most to you. Say, for example, you wanted to build a machine that will deftly play *GTA V*, but also have enough raw grunt to handle this year's other big PC gaming release, *The Witcher 3: Wild Hunt*. Your best path, in that scenario, would be to focus your efforts on a rig that values graphics performance above all else. Which is what we're doing over the next few pages—building a pure gaming machine. Of course, you can follow the general gist of this guide to build whatever suits you—focusing in on areas in which you want your machine to excel.

PERFECT MIDRANGE PC

CPU	
■ Intel Core i5-4590	$195
MOTHERBOARD	
■ Asus H97M-E	$95
GRAPHICS CARD	
■ XFX Radeon R9 290X	$310
STORAGE	
■ Crucial MX100 512GB SSD	$210
POWER SUPPLY	
■ XFX TS Series 550W	$66
MEMORY	
■ Corsair 2x 4GB DDR3 1,333MHz	$60
CHASSIS	
■ Corsair Carbide 200R	$62
OPERATING SYSTEM	
■ Windows 8.1 64-bit	$100
TOTAL	**$1,098**

Component Selection

Create your perfect PC with these fine ingredients



CPU *$195*

Intel Core i5-4590

Intel has stolen a lead over AMD of late, and as games continue to make more and more use of multiple-core architectures, we don't see that lead diminishing. If you've got a bit more cash and have a penchant for overclocking, then the unlocked Core i5-4690K is a great buy, but as overclocking isn't guaranteed to net you a boost in your games, this Core i5-4590 makes more sense financially. It still boasts a refresh of the Haswell core, turbos up to 3.7GHz from its base of 3.3GHz, and has a healthy 6MB of L3 cache. The retail spin includes a cooler, which is fine if you're not overclocking.

MOBO *$95*

Asus H97M-E

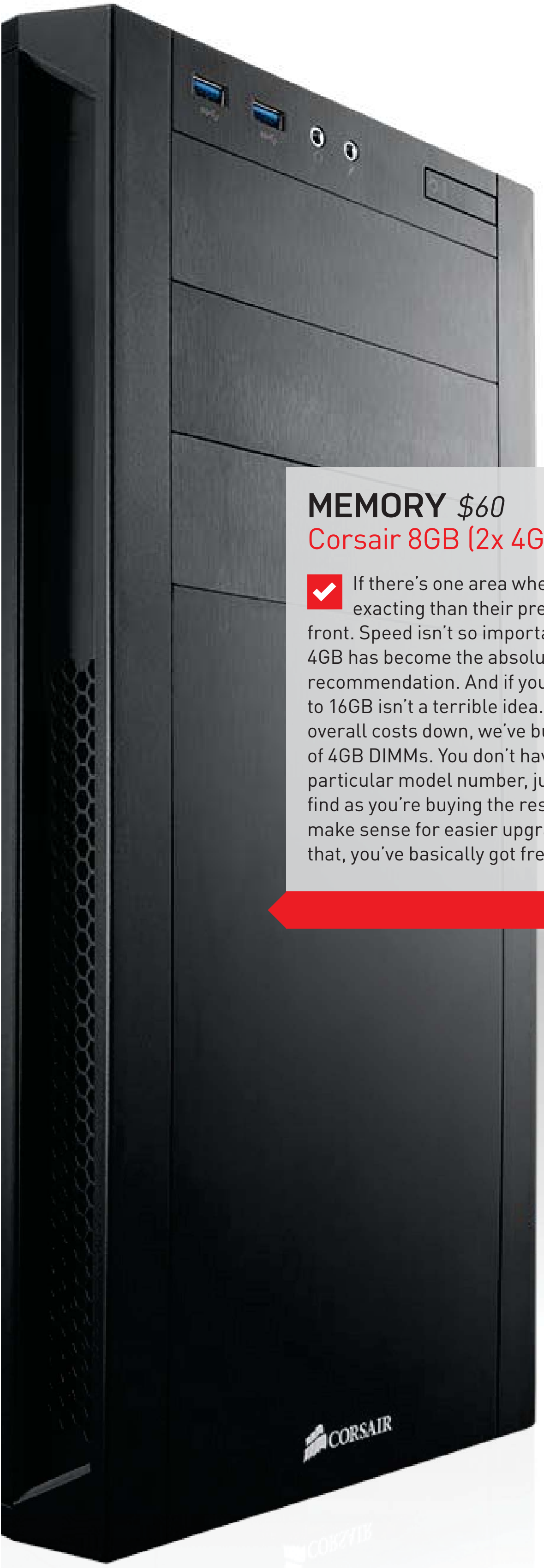
The H97 chipset that you'll find powering this motherboard is almost identical to the top-end Z97 chipset, but with one notable exception—it doesn't officially support overclocking. Given that we've suggested using a locked processor, that isn't an issue, and means we can go for a more price-conscious system.

The Asus H97M-E is a bargain motherboard that will give your Socket-1150 Core i5-4590 plenty of room to breathe, while supporting USB 3.0 and SATA 6GB/s interfaces as well as an M.2 slot. The only other point of note is that this Asus motherboard only has one full-length PCI Express 3.0 slot, which means that SLI/CrossFire is out, but we really don't see that as an issue right now.

GRAPHICS CARD *$310*

XFX Radeon R9 290X

Nvidia may have incredible graphics chips right now, but when it comes to knock-out value, it's hard to beat AMD's R9 290X. Available for as little as $310 if you shop around, the R9 290X has benefited from successive driver updates recently, putting it neck and neck with the often more expensive GeForce GTX 970. AMD's chip does run hotter than Nvidia's, but third party coolers solve this problem nicely. Both cards will happily run *GTA V* at high/highest settings, and should be able to handle the likes of *The Witcher 3*, too (if the recommended specs don't change). If you tend to side with the Nvidia camp, there's nothing wrong with buying that card over this.



STORAGE *$210*

Crucial MX100 512GB SSD

☑ We've been totally won over by SSDs now, and can't imagine loading from a spinning drive, even if our wallets depended on it. There is a slight problem here of course, which is that games are getting bigger and bigger: *GTA V* weighs in at 65GB. Factor in the size of the OS itself, and a few more games, and those affordable 128GB SSDs aren't as tempting as they once were. We see 256GB as the bare minimum these days, and even that's going to be swallowed up by a modest Steam collection. This is why we recommend the affordable MX100 in 512GB trim. You just can't beat it for the cash.

POWER SUPPLY *$66*

XFX TS Series 550W

☑ Intel has really hammered down on its power draw with its latest processors and motherboard chipsets, which means you don't need a particularly meaty power supply in order to run them. SSDs aren't as hungry as hard drives either, so it's really only the graphics card that's going to tax your PSU of choice. Better yet, the R9 290X isn't too demanding, so the whole system is still going to draw something under 400W, even under full load. The extra power capacity gives you options for upgrading as you go, and it also means that the PSU is running efficiently.

Go with a name you can trust and you shouldn't have a problem, which is why we've opted for the XFX unit.

MEMORY *$60*

Corsair 8GB (2x 4GB) DDR3 1,333MHz

☑ If there's one area where modern games are more exacting than their predecessors, it's on the memory front. Speed isn't so important, but capacity is. These days, 4GB has become the absolute minimum, with 8GB now the recommendation. And if you can stretch to it, jumping straight to 16GB isn't a terrible idea. In the interests of keeping the overall costs down, we've built this machine around a pair of 4GB DIMMs. You don't have to doggedly track down the particular model number, just go with whatever deal you can find as you're buying the rest of the components. Big names make sense for easier upgrades later, of course, but beyond that, you've basically got free rein.

CHASSIS *$62*

Corsair Carbide 200R

☑ We've recently built several machines using smaller chassis, just because they no longer limit your component selection, but it's still great to go back to building in a bigger case. The Corsair Carbide 200R impressed us the moment we saw it, and it continues to set the standard by which we judge other chassis. The tool-free design makes it easy to build in, and there's plenty of room for the R9 290X, as the drive cages are split at just the right point to accommodate this long card. Cutouts make cable management as easy as you could hope for, and there's plenty of room for extra cooling should you need it as well. This is an incredible case for the money.

Time to Piece It All Together

YOU'LL NEED THIS

SCREWDRIVER
The Carbide 200R may be a tool-free case, but you'll still need a screwdriver when it comes to securing your motherboard in place.

BEFORE WE START, it's worth pointing out that we've made some assumptions when it comes to gear you already own. We take it for granted, for instance, that you have a screen you can plug your new PC into. If you want to supplement your new baby with something fresh, there are plenty of great panels available right now, for example the budget AOC E2250SWDNK ($160) or the sexy Philips BDM4065UC ($979). We also suspect you already have a keyboard and mouse.

As you may have noticed, there's also no optical drive—we assume you've an Internet connection. Honestly, we rarely use them these days, and the only thing we can think of doing with them is ripping old music CDs, and even that seems like a hassle. If you do need one, for whatever reason, we'll work on the basis that you've got one laying around from an old PC that you can cannibalize for the purpose. Failing that, you can pick one up for around $20.

1 INSIDE OUT

Start by making sure that everything works. Put the case to one side for a moment, rest the motherboard on top of the antistatic bag in which it arrived, and then drop the processor into place. Next, slot in the two memory sticks and gently slide your graphics card into place.

2 GREASE-UP

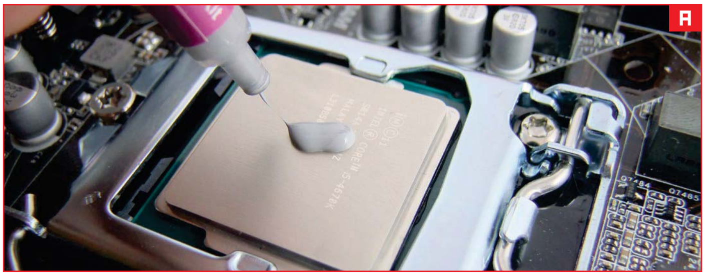
Before you attach the CPU cooler to the board, remember to dab on a blob of thermal grease [**Image A**]. This will ensure that there is good contact between the top of the chip and cooling plate, filling any small scratches and bumps on either surface with thermally conductive goo. A blob roughly the size of a couple of grains of rice will suffice. Don't worry about spreading it; simply attaching the cooler will ensure that it squidges out in a nice even layer.

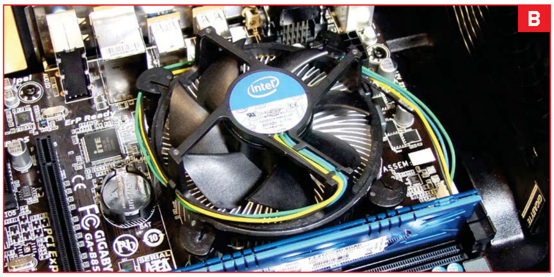
3 POWER PLAY

Plug the cooler's power cable into the correct header on the motherboard—this is next to the processor socket on this motherboard. Do this without plugging in the PSU, just to ensure that everything is plugged in before you give it a jolt. Make sure the main ATX cable is attached, as well as the 8-pin CPU power cable [**Image B**]. You'll need to attach the 6-pin and 8-pin PCIe connectors to the graphics card, too.

4 NAKED BOOT

Don't worry about attaching your drives at this point. Connect your screen to your graphics card and plug in your keyboard. Power up the PSU and start up the barebones machine—short the power pins on the front panel connector with a screwdriver to get your machine up and running. Check the manual for the PWRBTN location on the mobo.





5 BIOS BEWARE

What we're checking for here is that the machine starts up, its fans spin, it gets to the POST screen, and it allows you into the BIOS. When it reaches the mobo logo screen, hit Delete, and the rig should enter the BIOS setup. Make sure the motherboard is reporting the correct CPU and the right amount of RAM.

6 START AGAIN...

Next, shut down the machine and unplug the PSU. Disconnect the power cables from the mobo and remove the graphics card. You can leave the RAM, CPU, and cooler in place as you drop it into your waiting case.

7 STEADY SUPPLY

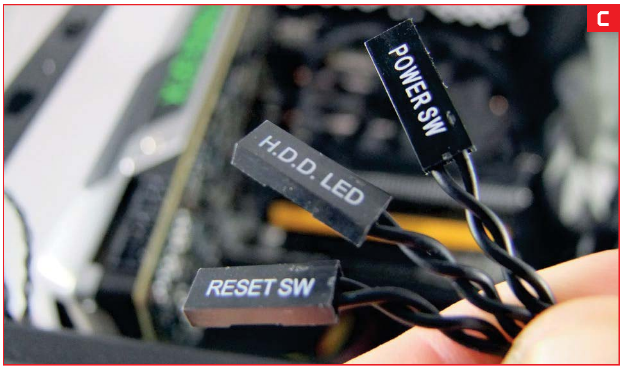
Before you insert the heart of your rig, get the PSU in place. The Cthulhu's maw of tentacles sprouting from the power supply is much harder to manage once the other components are in place. Orientate the PSU so the intake fan is positioned to suck in air from the outside.

8 BOARD MEETING

Now it's time for the good stuff. Attach the mobo backplate into the case. Pulling the mass of cables out of the way—you don't want to trap any leads—screw the mobo risers into the chassis and drop the board into place.

9 DRIVE TIME

The next component to add to your Carbide 200R is the bargainous MX100 SSD. You have plenty of options as to where you actually mount this drive, but we've gone for the racks at the front bottom of the case. Attach the SATA cable and you're ready to move on.



10 BE DISCRETE

It's now time to install your Radeon R9 290X. Ensuring you're not trapping any errant wires, drop the graphics card into the primary PCI Express slot, and screw the bracket into the chassis to keep it safe and secure.

11 PANEL POWER

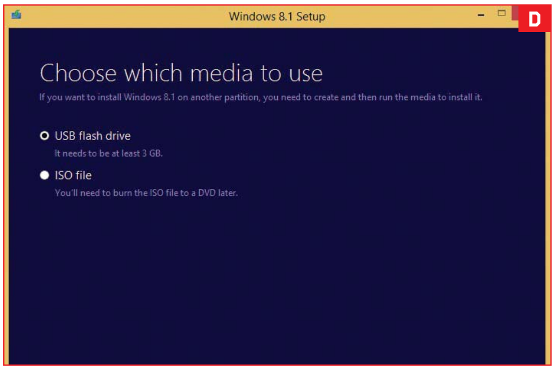
Plug the chassis front panel connectors to the motherboard pins [**Image C**]. It's worth consulting the manual, at this point, to locate the connector for the front panel audio and USB headers. You know where the power pins are—the reset switch, storage, and power lights will be in the same place. Attach the cables securely.

12 CABLE TIES

Time to attach the power cables. You should be able to route the cabling so it doesn't obstruct the airflow throughout the chassis. Plug in the long motherboard power cable first, and then the CPU, GPU, and storage power connectors, and make sure the fans are powered, too.

13 CLEAR AIR

That's all the essentials taken care of, so now you're ready to connect your screen, keyboard, and mouse. Leave the side off the case when you boot for the first time, so you still have a good view of the insides, to ensure that all of the fans are spinning properly. Press the power button and your build should spring into life. Once it does, give the Delete key a quick tap to hit the BIOS again.



Windows 8.1 Setup

Choose which media to use

If you want to install Windows 8.1 on another partition, you need to create and then run the media to install it.

○ USB flash drive
It needs to be at least 3 GB.

● ISO file
You'll need to burn the ISO file to a DVD later.

14 RAM-ING SPEED

In the BIOS, check that the CPU temperature is normal (anything below 40 to 50 degress Celsius) and make sure the storage drive is now visible and set as the primary boot option. It's also worth dropping in to check the RAM settings and get the sticks running at their rated frequency using the relevant profiles. Save your BIOS settings and exit.

15 OS INSTALL

With modern rigs, you're unlikely to have an optical drive to install your operating system from, so you'll need to create a USB install on another PC [**Image D**]. Check out http://bit.ly/198H4GQ to read our easy guide to making a Windows 8 install. If you're feeling brave (and haven't bought a Windows licence), you can instead download an ISO of the Windows 10 preview installation, which we've been using for a while now and had absolutely no problems with.

16 BOOT AND GO

With your chosen USB media attached, boot from it via the BIOS, and go through the whole setup procedure. Whatever OS you're running, this is pretty painless these days. Once completed, the most important thing will be to make sure that you have Internet connectivity. Once you're done, update your graphics card drivers, and then get *GTA V* installed inside Steam. Job done. It's time to start playing. ⏻

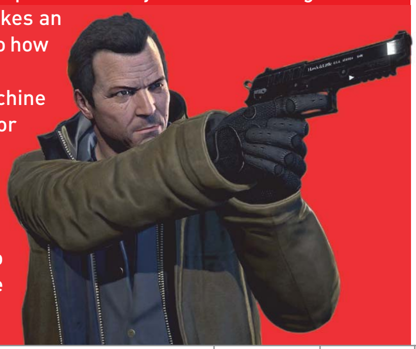
A PC FOR THE GAMES TO COME

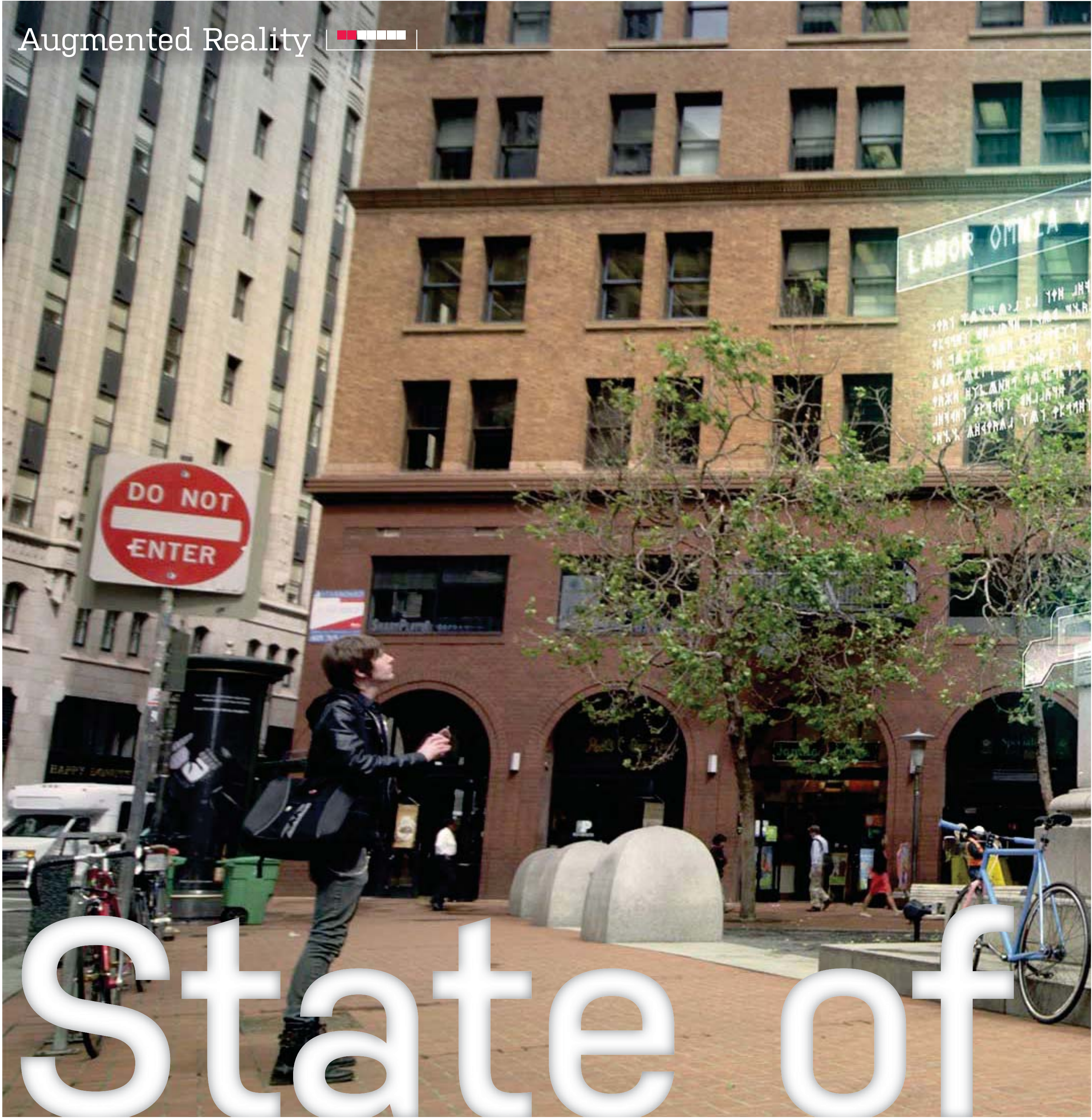
We've put together a great PC without spending a fortune. This is a testament to the current state of the PC industry—there's incredible hardware at the high end, but aim slightly lower and you have the perfect combination of great performance and fantastic value. Here is a machine that will last you at least a couple of years of cutting-edge gaming, yet it doesn't have the kind of price tag you'd expect. With the hardware rolling in at under $1,000, there's a lot to like.

We've built this machine with a specific purpose in mind—getting the most out of the serially delayed *GTA V* (and as an aside, the soon-to-be-released *The Witcher 3: Wild Hunt*). Whatever reason you're building your rig for, the same logic behind component selection and the building process remains.

As for this build, the good news is that all those delays to the release of *GTA V* appear to have been spent tweaking and honing the engine to make sure it's optimized for PC. We ramped up pretty much every setting we could find to max and the game continued to run at 60fps. One setting we'd recommend is the High-Resolution Shadows setting, which can be found under the Advanced Graphics setting menu. This makes an incredible difference to how great the game looks.

To be fair, this machine is probably overkill for *GTA V*. You could build a cheaper gaming PC that would still hit 60fps in Rockstar's latest. We've aimed so very much higher here because we just wanted to build a rig that will be able to handle anything that's going to be released this year. To that end, we're happy with what we've achieved for a fairly reasonable budget.





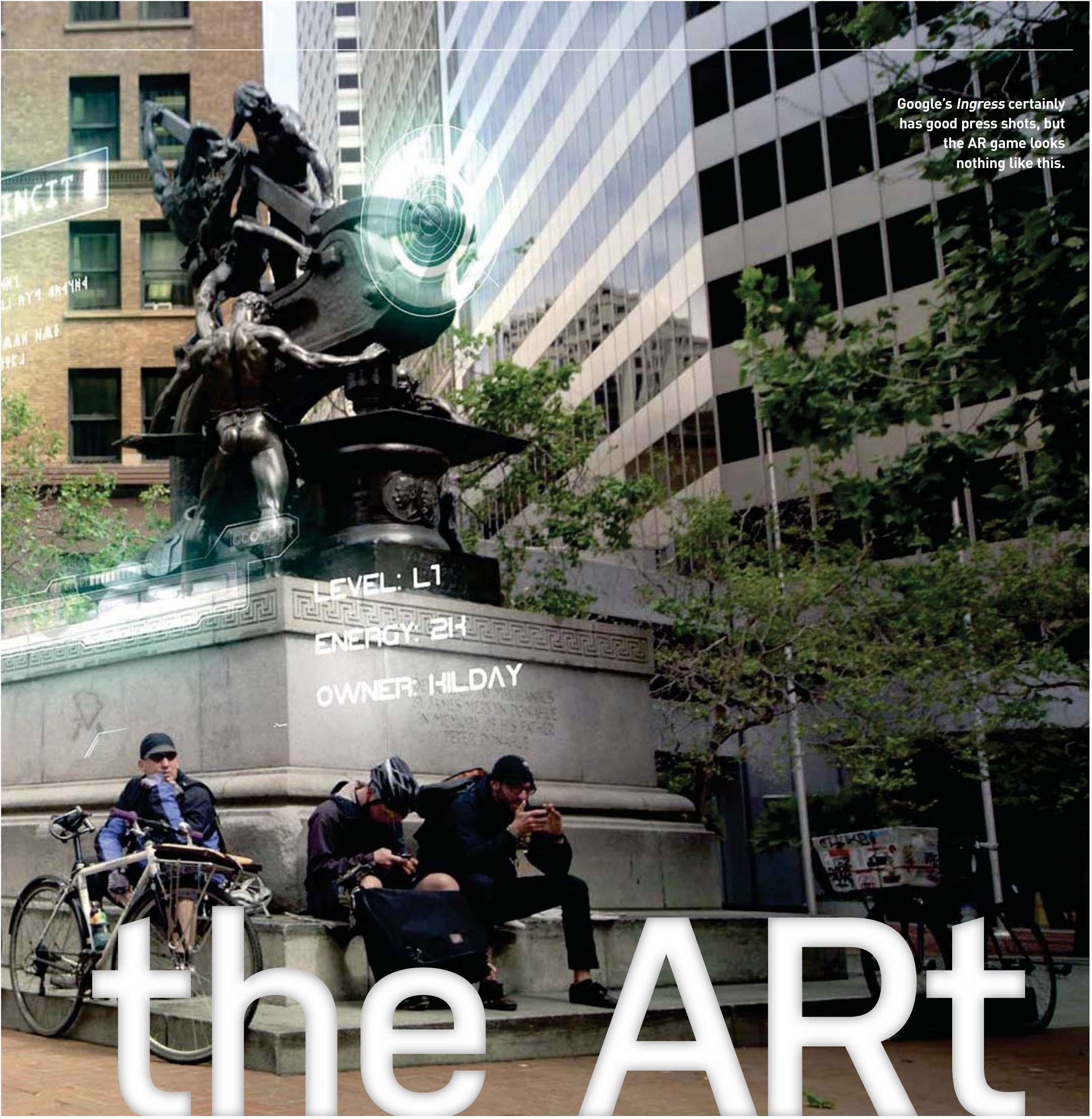
State of

Why augmented reality technology is more than just virtual reality's kid brother

By Daniel Griliopoulos

Read the tech and games press, and the buzz is all about virtual reality. Valve revealed its long-hidden VR product Vive, built with HTC, in March. Oculus Rift, meanwhile, has been bought for a cool $2 billion by Facebook, with Facebook's owner Mark Zuckerberg calling it "the dream of science fiction" that will "unlock new worlds for us all."

Yet, quietly, people are whispering that the real story is augmented reality (AR). Influential data firms such as Juniper



Google's *Ingress* certainly has good press shots, but the AR game looks nothing like this.

the ARt

Research have even put figures on it. Juniper's "Augmented Reality 2015–2019" report predicts revenues of $4.1 billion for AR apps in 2019, with 1.3 billion apps in use. By contrast, Digi-Capital is advising that AR could be worth $120 billion by 2020, with VR valued at a mere $30 billion. That reflects fundamental differences in both the underlying experience, and the progress made, in each field. We'll explore why that is, and whether virtual reality has any chance of catching up.

We'll delve into the way big media corporations—including Microsoft, Valve, Google, Apple, and Sony—are looking at this space. Several have already invested billions—such as Google with Magic Leap, and Microsoft with HoloLens—while others have already walked away, such as Valve, with its deliberate pivot toward VR.

That also means examining how AR tech is currently working, and where the next steps will be. After all, low-grade AR has become commonplace in several types of mobile application and is looking to become more widespread. Digi-Capital's prediction is based on AR capturing a large chunk of the cell phone market—with over a billion smartphones already shipped, you could say $120 billion is a conservative estimate.

But then it's only talking about five years away. It took 20 years for cells to move from the Nokia Ringo, which could merely call people, to today's all-singing, all-dancing smartphones. Will AR move faster? For the lowdown, read on.

Microsoft's Kinect was disappointingly under-used.

The core difference between virtual reality and augmented reality technology is the worlds they move us into. One replaces, the other improves. Virtual reality creates a new world for you. It may be a world identical to the one you're in now, or it may be a world built entirely from bones and elves, but it's a world that's fundamentally separate from the world we inhabit. No perception that you see through virtual reality is what's outside of that headset. You're totally immersed. It's therefore a tech for totally immersive experiences—escapism like movies or games.

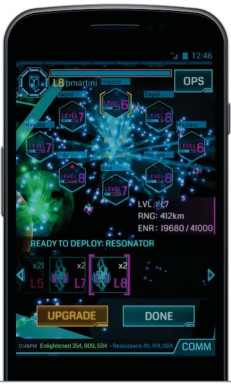
Augmented reality, by contrast, focuses on the real world as the base, and builds on top of it. AR generates virtual items in this world by either using a whole mess of sensors to ensure they're correctly placed on its surfaces, or ignoring them completely and placing it on a much nearer plane. Though this sounds easier, as you don't have to generate an entire world, there are technical challenges that make versions of it just as tricky to do as VR.

AR's not so good for immersion, because the real world is always there in the background. But that makes it an excellent tool to use to add virtual things to the real world. Voice calls, advertising, mapping, social networks… or even what Tim Merel of Digi-Capital calls "a-commerce." Yes, we're talking about augmented shopping.

There are degrees of augmentation, of course. Device-led AR, where the AR is imposed on a screen that's distant from the viewer, is a mediated reality that allows developers to more simply judge the environment. At its simplest, this acts as a head-up display (HUD) that sits over the scene like a 3D movie title sits on its background. This basic tech is at the level that firms such as advertising innovators Blippar or Aireal use. It simply uses your existing device and an app, and then imposes a new image on an existing scene, for example by putting an animation of a football player near his promotional merchandise.

At a slightly more advanced level, this tech can detect a surface or shape in the environment, and use that as a marker to estimate relative depths in the scene. You'll have AR apps that use special "fiduciary marker" cards to anchor their sim, and allow the app to scale and rotate a virtual simulation to fit the environment.

The more VR-like AR requires a lot of extra tech. You need to be able to track the position of the viewer's head and eyes, and judge relative distances, to make the illusion of something virtual be convincing. Most of these AR devices use a head-mounted display (HMD), which is a headset supporting a display device (or two) in front of the user's eyes. The sort of HMD we're interested in also tracks head position along six degrees of freedom—a phrase that means three components of translation (up-down, forward-backward, left-right), and three components of rotation along those axes.



Google's *Ingress* app uses photos of real-world places for an MMO mapping game.

There are more extreme techs in the works as well. Two different sets of contact lenses are in development, one academic, one military. The military ones are called iOptik and function much like bifocal lenses, with the twist that they're designed to work only with AR goggles. These contact lenses will allow humans to focus both on the background scene and the HUD on the goggles at the same time. Though they're being developed for the US Department of Defense, the company behind them hopes it can sell them as consumer products soon.

The more interesting academic tech comes from the University of Washington, and is a set of "bionic" contact lenses powered by radio waves and with LED displays built in. (The microfabrication process that means they self-assemble their circuitry using osmotic pressure is fascinating and totally irrelevant). At the moment, the lenses have only been tested on rabbits, so it's still at an early stage, and there are questions about the quality of the images it produces. Still, it's an impressive glimpse of the future.

Of course, this is all minor stuff, mostly built in the hope that the big technology firms will buy out the company behind it. What's of greatest interest right now is what those firms are focusing on, and what they think they can do with it.

VALVE'S BLOWN OUT

What's most interesting about Valve's AR offering is that it's no longer *Valve's* AR offering. After a Night of the Long Nerds in 2013, Valve released 25 people, including its entire AR team, to focus, we presume, on VR. The two AR project leads were given Valve's permission to do whatever they liked with the tech that they'd made, which they've called CastAR. They've created a company called Technical Illusions to finish it off.

CastAR is a bit different from other AR. It consists of a pair of polarized glasses with built-in projectors and cameras, and a separate retro-reflective surface studded with infrared LEDs. The camera uses the LEDs to track your head

Try AR Today

There are many ways to try augmented reality today. As it's a more mature technology, there are some basic devices that take advantage of it already, as well as many cell phone applications to try. The Carl Zeiss VR One headset, for example, supports AR features and will work with any iOS or Android headset between 4.7 and 5.2 inches. Google Glass V1.0 may have been canceled, but that's out there too.

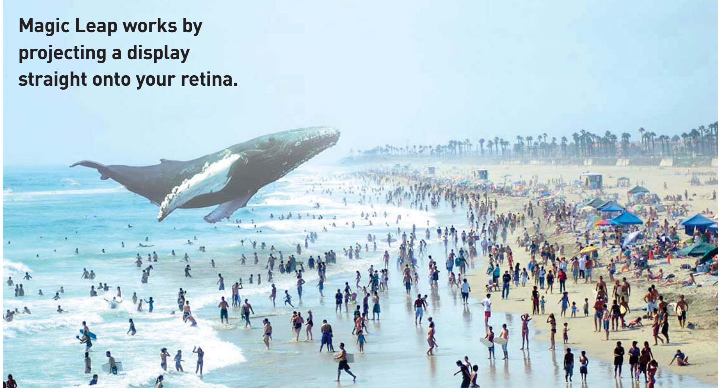
There's a huge array of AR apps for smartphones. One of our favorites is GoSkyWatch Planetarium for iPhone and iPad. This is one of many stargazing apps that use the device's accelerometer and GPS to orient your device, so wherever you're pointing, it shows constellations, stars, and nebulae. See also Anatomy 4D, Google Goggles (which can translate text on the fly), Field Trip (which lets you know about nearby attractions), and iOnRoad Augmented Driving, which gives speeding alerts, crash warnings, and driving analytics.

The Playstation Vita has AR features, and comes with a package of free AR games, such as *Table Ice Hockey* and *PulzAR*. Similarly, the Nintendo 3DS comes ready-loaded with AR Games and six AR cards. Every game is superimposed on the real world, but has no interaction with it. It's more of a gimmick, really.

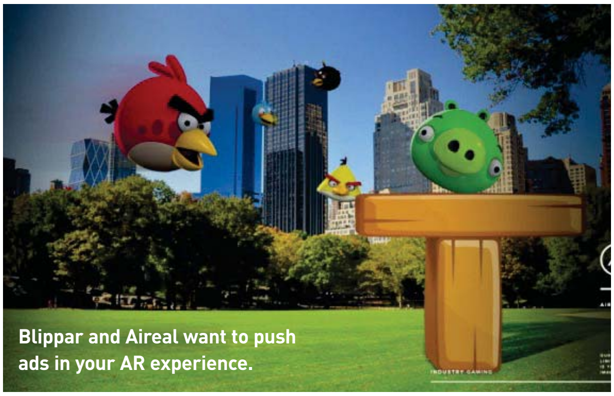
If you've got a PS3, you could pick up a copy of Wonderbook. It was a Harry Potter–inspired AR tome with blank pages that only filled when viewed on your TV through the Playstation Eye camera. Similarly, the PS4 has *Playroom*, a much smoother AR sandbox where you can play with small robots that are running around your living room. Kids love it.

You can also try the Kinect system, on both Xbox 360 and Xbox One. Though it never got the backing it deserved from developers, it has a uniquely detailed depth camera that means it can track your entire body shape—or several, in the Xbox One's case—on-screen. It's probably the most advanced consumer AR tech available on the market today.

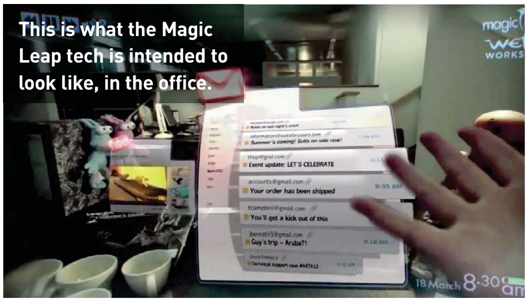
The Google-funded Magic Leap team includes superstar SF novelist Neal Stephenson.



Magic Leap works by projecting a display straight onto your retina.

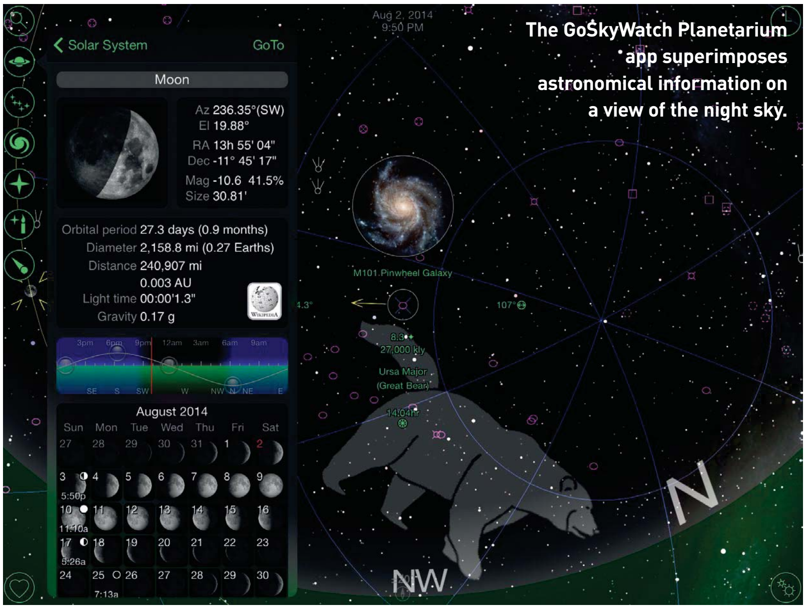


Blippar and Aireal want to push ads in your AR experience.



This is what the Magic Leap tech is intended to look like, in the office.

magic
WE
WORKS
18 March 8:30 am



The GoSkyWatch Planetarium app superimposes astronomical information on a view of the night sky.

Aug 2, 2014
9:50 PM
Solar System
GoTo
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SE S SW W NW N NE E
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M101 Pinwheel Galaxy
Ursa Major (Great Bear)
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Az 236.35°(SW)
El 19.88°
RA 13h 55' 04"
Dec -11° 45' 17"
Mag -10.6 41.5%
Size 30.81'

Orbital period 27.3 days (0.9 months)
Diameter 2,158.8 mi (0.27 Earths)
Distance 240,907 mi
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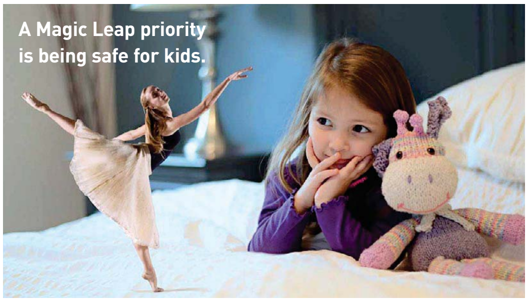
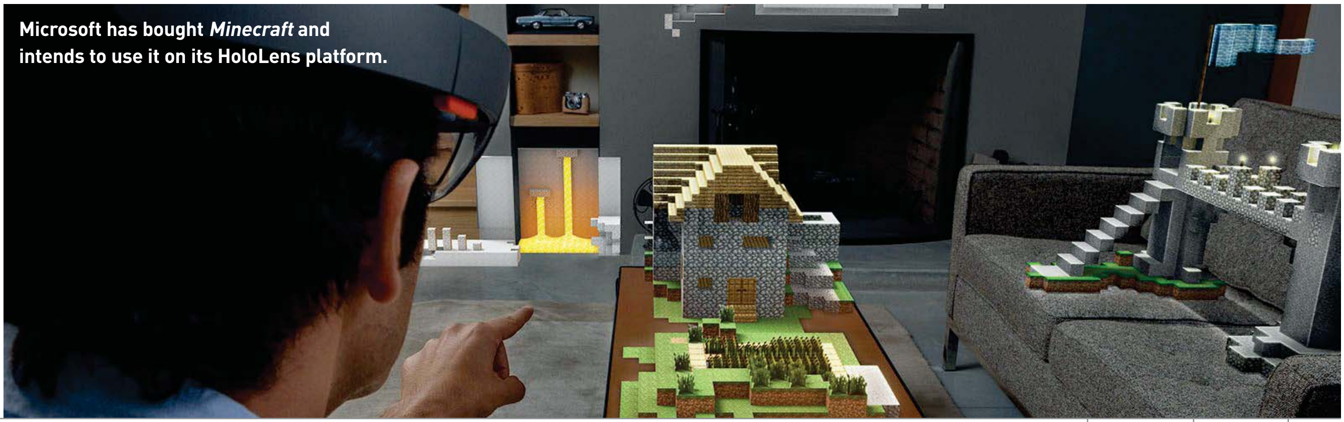
Gravity 0.17 g



A Magic Leap priority is being safe for kids.



Microsoft has bought *Minecraft* and intends to use it on its HoloLens platform.

movement, so it can adjust the images that the projectors cast onto the surface. This means each polarized lens gets a different, but coherent, image. Low latency lets you do things like look around an object. In other words, it projects a self-contained virtual reality into the real world.

As a result, it's used for static purposes rather than something more mobile, like the existing Samsung Gear VR and Nintendo 3DS. CastAR's pitch video focuses on a variety of ways that it can be used: preview 3D architectural blueprints, play 3D board games remotely on unexpected surfaces, create 3D presentations, and just for use as a 3D desktop computer. As long as you put that retroflective material all over your house.

MICROSOFT DOES EVERYTHING

You've almost certainly heard of Microsoft's contribution to the AR party—its HoloLens system for Windows 10, and possibly Xbox One. It seems revolutionary, but its use of the word "holographic" might be suspect (and mainly due to affection for *Star Trek*'s Holodeck). Kinect seemed revolutionary in the hermetic demonstration settings you get at big tech trade shows.

HoloLens definitely looks impressive from the screenshots scattered around these pages. It's a futuristic headset that superimposes 3D creations into the world and allows you to interact with them. The impressive element here is how high-quality the images it produces are—from the videos and reports, it's utterly compelling, if nowhere near as immersive as the HTC Vive or the Oculus Rift.

The actual headset is a lot bulkier than a comparative AR headset—Google Glass, say—but then, this has the power of a true virtual reality headset because it's not doing a simple 2D overlay. It reportedly weighs around 400g, is adjustable to all head sizes, and is totally wireless. It consists of holographic lenses, depth cameras, and three separate processing units—one central, one graphics, and one holographic.

The depth cameras are built from the same tech as Kinect, but are lower power, have a wider viewing angle, and are placed around the front and sides of the headset. They track both the user's head and hands, as HoloLens is controlled entirely by gesture and voice, *Minority Report*–style. This lets you interact with the 3D virtual models of the apps, from building blocks in *Minecraft*, to sculpting the bodywork of a motorcycle. MS is working on "pinning," which will let you stick these models in place in the environment, so you can move around them, and "holding," so you can pick them up and manipulate them.

The apps are really what wowed us when HoloLens was announced. Microsoft recently bought *Minecraft* for $2.5 billion, and it's already made a version of it that runs on HoloLens. Similarly, NASA has an app that lets you explore Mars, and there's a version of Skype that runs on it so that a builder can explain to you why you should have spent more time in carpentry classes at school. Though the reports are mostly positive, the tech was in an early stage, and there were concerns over whether the hardware could fit into a consumer unit, and the regularity with which the illusion was broken.

That's not all, however, as Microsoft also has several other AR and VR projects underway. It definitely has an AR headset ready to go—Microsoft bought the smart glasses firm Osterhout Design Group in March 2014. And another project called RoomAlive was shown off in October 2014, consisting of a set of projectors that transformed the walls of an entire room into an interactive environment.

Digressing for a moment, there are also persistent rumors about a VR headset for Microsoft's Xbox One console. After all, the *Wall Street Journal* said back in March 2014 that the company already had 3D virtual reality tech ready to go. HoloLens has reduced the chances of that coming to market, but we assume Microsoft has it ready as a backup.

GOOGLE DOES IT BETTER

Google Glass was Google's high-profile effort in the field of augmented reality, and you might argue that it was the company's first high-profile failure, given that Glass has currently been removed from sale ahead of a redesign and a new model. The device is a set of (quite pretentious-looking) plastic and metal glasses, with a HUD projected onto it

What About VR?

We've covered VR in the past, but it's worth giving you a quick status update as to where the tech is today. There are three projects that are nearing release. Sony's Project Morpheus, Valve and HTC's Vive, and Facebook's Oculus Rift.

Of these, Oculus Rift is the oldest, and several developer iterations have been released. A mightily cut-down version of it made to work with Samsung smartphones, the Samsung Gear VR, has already been released. It works by slotting a Samsung Note 4 or Galaxy S6 into a viewing device, and runs with 1280x1440 on each eye, and a 96-degree viewing angle.

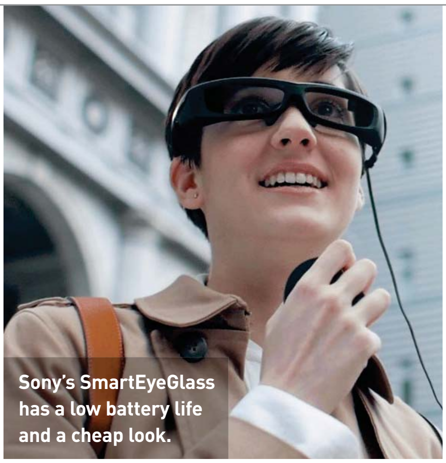
Despite that, there's still no sign of the Oculus Rift consumer model. The most up-to-date version, the Crescent Bay prototype, has a positional tracking camera for your head, low-persistence OLED display (to eliminate blur), and runs two screens at 960x1080 on each eye, at 90Hz, and a 110-degree viewing angle. No release date has been announced, but late 2015 seems likely.

Sony's Project Morpheus is the quickest-developed of the three. Like its AR solution, Sony seems more concerned with getting a working version of its tech to consumers than with making it the cutting edge. The version we tried in July last year was much lower resolution and fidelity than the Oculus Rift versions we'd tried up to that point, but both companies have since substantially improved their hardware. It has a similar OLED screen running at 960x1080 on each eye, a 100-degree viewing angle, and a 120Hz refresh rate. It was very comfortable, presumably because much of the hardware was sitting in a set-top box, not on our heads. It tracked our heads using the Playstation camera, and it had true 3D audio. It's due out in early 2016 for PS4, which already has motion-sensitive controllers.

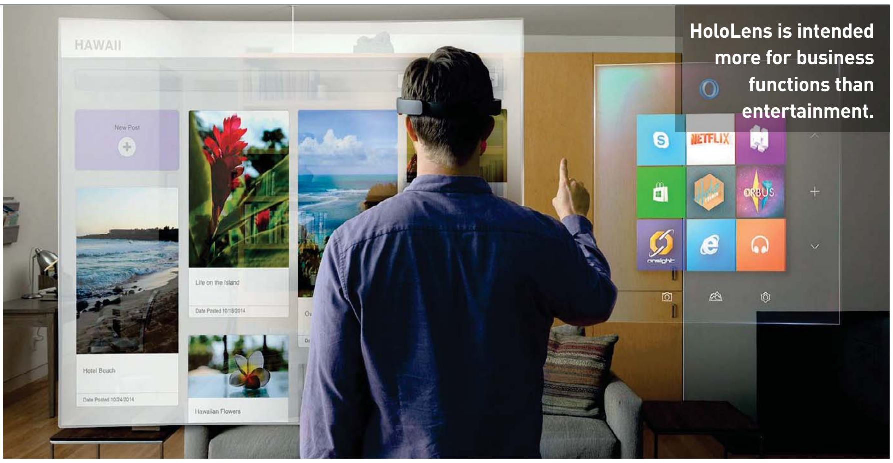
Valve and HTC's Vive headset is the most impressive. It recognizes that some of the joy of VR is in interacting with those virtual worlds, so it does two things. First, it has a pair of bespoke controllers for you to hold, allowing limited interaction. Second, it has a set of cameras that sit in the corner of your room, detect your location and any obstacles, and track your movement, as well as setting the virtual world's limit at your real world limit.

Vive has two 1080x1200 screens running at 90Hz. As the screens are narrower, you'll have a wider vertical field, and it should be lighter, as your PC will do all the processing work. Its big selling point is its pair of motion-tracking cameras, which are infrared and wireless, and are used to follow the headset's 37 sensors. This enables you to roam freely in your room and the virtual world. It works with multiple players and should be out this year.

If you want to try VR today, you can get a casing for your smartphone, like the free Google Cardboard, or a cheap third-party headset like the $45 Immerse from Firebox.



Sony's SmartEyeGlass has a low battery life and a cheap look.



HoloLens is intended more for business functions than entertainment.

Magic Leap's stated aim is to reintroduce magic into our lives.

With $500 million in funding, Magic Leap can make any number of virtual seahorses.

and a smartphone-like processor behind it all, which was on sale for $1,500.

Glass did everything you thought it should, like understand natural voice commands, record video, take photos, and all the update elements of your phone. It had a small touchpad on the side of the device, which let you browse a timeline of recent events. The screen was a liquid crystal on silicon device with an LED-illuminated display that used polarization and reflectors to bounce the image into your eye. It had a wide range of supported Google apps, including Now, Gmail, Maps, and Google+. All good then? The fact that it's on a forced hiatus says otherwise.

That's not all of Google's AR efforts though. It's also making simple augmented reality games for its Android phones, such as *Ingress*, a massively multiplayer location-based game built on Google Maps. And it has Project Tango in the wings. This is a standard tech for mobile devices that allows them to navigate the physical world in the same way we inefficient meat-bags do. It uses advanced computer vision, image processing, and special image sensors to make an end-to-end navigation technology that understands its own 3D motion in the world, can perceive depth, and use visual cues about areas or objects they know to constantly self-correct. At the moment, it's only available to core developers, but we assume it'll be integrated into next-generation Android hardware.

Magic Leap (www.magicleap.com) is yet another Google-funded project, coming in at $542 million, and a direct challenge to HoloLens. It's being built by a team of tech and games industry veterans, including the author Neal Stephenson and the 3D team at WETA (who made the *Lord of the Rings* special effects). Reports have it as more believable and solid than HoloLens. It works using a virtual retinal display, that is, a display projected straight onto the retina itself.

Similar to HoloLens, the simulation looked utterly convincing. The animated 3D creatures it portrayed looked detailed and sharp, and sat well in the surrounding world. And similar to HoloLens again, it ran on a huge piece of hardware (essentially a PC) sitting nearby, rather than in the headset itself. It's worth looking at the promo video to see what it's capable of. Magic Leap hasn't really been announced or promoted yet, but we're expecting it to launch in 2016 or 2017.

SONY'S "ME TOO" TENDENCY

The Japanese giant always seems to want to get involved in any new tech, but recently it hasn't been leading the market here. Its Project Morpheus feels like a "me too" VR solution, but it'll surely work well on Playstation 4 and might actually sell well (see "What About VR," opposite). Plus, it's already experimented with AR in the form of The Wonderbook for the Playstation 3 (see "Try AR Today", on page 50).

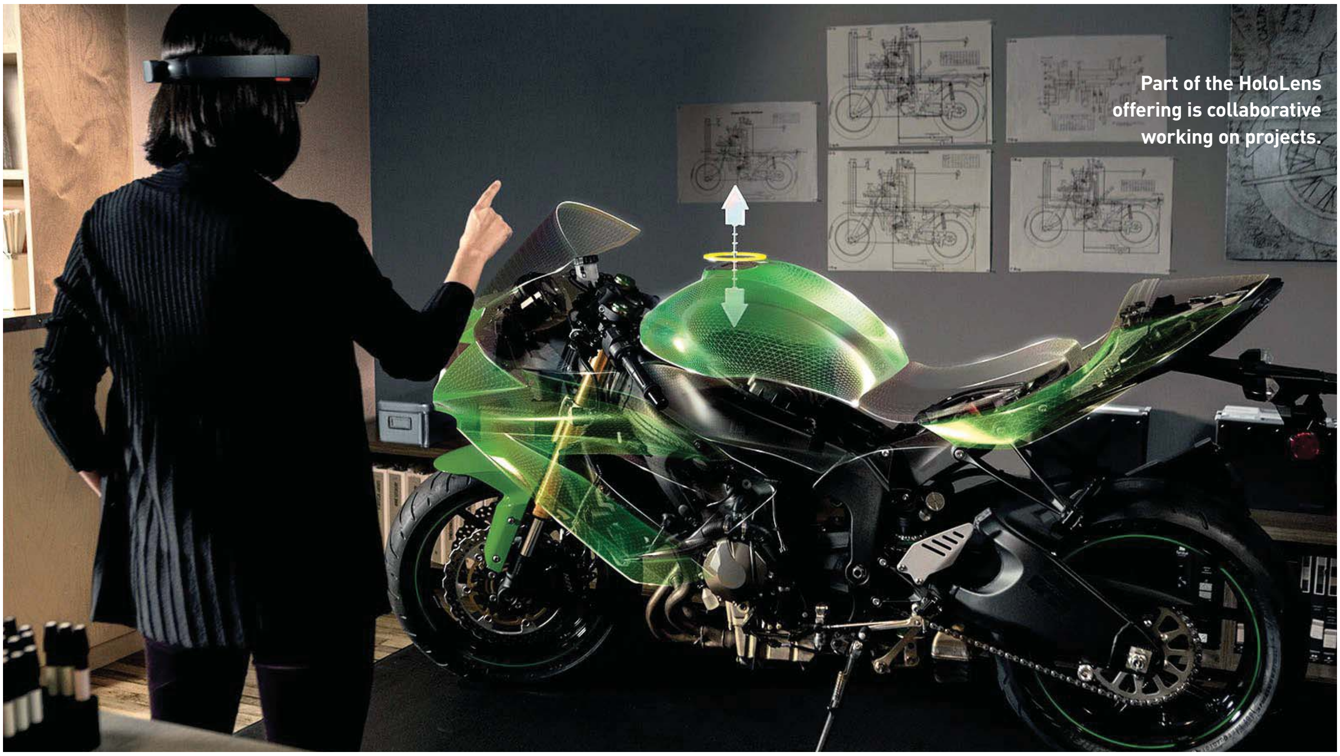
However, SmartEyeGlass is its main foray into AR. The currently available SmartEyeGlass SED-E1 Developer Edition is very similar to Google Glass, though much cheaper at just $840. It uses "holographic waveguide technology" in 3mm AR lenses, which produces something very similar to Glass, with overlaid green text and diagrams operating at 15fps. It also has a 3MP camera that can take pictures or video.

It connects to compatible Android phones by Bluetooth, and is controlled by a small, ugly-looking puck that sits on the user's lapel, which also doubles as microphone, speaker, NFC, and battery (which comes in at only 150 minutes). At the moment, we'd stay well away from this device. It's ugly as sin, with a poor battery life, and not many apps. Version two could well be worth looking out for, though.

APPLE OF THE EYE

There haven't been any official reveals of Apple's research into VR, but then Apple is more tight-lipped than a close-mouthed clam ahead of *any* announcement. Apple does have several patents for AR tech—there's a very interesting one for a "transparent electronic device" that sounds very much like a piece of augmented reality tech. Examples in the patent include using the device to overlay information about a museum exhibit. Interestingly, the device would be able to make itself opaque, and only display selected elements of the background world, otherwise being a normal opaque LDC or OLED display.

That said, an analyst from investment bank Piper Jaffray (annoyingly, but understandably,



Part of the HoloLens offering is collaborative working on projects.

investment bankers get a lot more access to tech firms than journalists do) published a report in March saying he believes Apple has a small team experimenting with the AR space, but that they think consumer AR is still 10 years off. We'll see from Microsoft and Google efforts whether they're wrong, but they might be on the money when it comes to mass-market success.

THE STATE OF THE ART

As that $120 billion valuation by Digi-Capital might indicate, there's a lot of hype around AR and VR at the moment. Hundreds of firms are trying out strange new tech to augment the senses. UK firm Ultrahaptics, for example, uses targeted ultrasound vibrations on a user's skin to form tangible shapes and textures from thin air, so the users can feel them without the need for worn equipment. That, combined with the hand-detecting Leap Motion device, makes for delicately convincing sims, like brushing your hands over ghosts. For VR, we've seen every type of treadmill under the sun—giant balls, resistant pads, harnesses around the waist—anything to convince you that you're in the virtual world.

On balance, the hype is justified. It's not like the first tablets, when Microsoft launched them stillborn into the market. Too many big companies are competing here for this to not be a success for one of them. But challenges remain, and they're not insubstantial. The biggest are in shrinking the tech down to a headset, or headset-and-pack model; in maintaining persistent simulations while doing that; and in preventing object-placement errors. It's likely that, after all this experimentation, smartphones will be the first devices that give us a real taste of this. As always in that field, Apple will be the company to watch. That said, Google's Magic Leap investment is considerable enough and the tech advanced enough that we'd cautiously predict it'll be first to market, albeit in a reduced form.

One prediction we're happy to make is that in 20 years time we'll be looking back at this tech the way we now look back at the first cell phones. These innvoations are going to revolutionize many things—anything that requires 3D knowledge, such as architecture or warehouse management; anything that requires management of large data sets, such as programming; and anything that simply wants to look pretty, like art or video games. Now we just have to wait for the hardware to catch up.

The AR Hardware

Not all AR devices share the same hardware and software, but there are some basic technology aspects they all need. First off, you need a processor to work everything out, then a transparent display to show the world and the projections, a light power source, and a variety of sensors and input devices.

The sensors can take several forms, but are mostly included as standard in smartphones. An accelerometer lets you measure impetus, a GPS measures global location, and a magnetometer or solid-state compass measures the device's orientation against Earth's gravitational field—that is, the ground. Luckily, modern smartphones contain all of those things.

For AR technologies that aren't based on cell phones, if you want all these elements, they have to be built in, which can increase the size and cost of the device substantially. If you choose to go without them, you'll lose a huge amount of functionality. It's notable that Sony's AR glasses system has a relatively large external box clipped to the user's lapel, while both HoloLens and Magic Leap have been demoed with large tabletop external units that were actually running the tech.

Input systems are another challenge. Unlike with virtual reality, the user can see their hands, so a keyboard is an option. But also unlike VR, augmented reality encourages users to be mobile. You want to look around the object and touch it, so you want your hands to be either free or holding interactive objects (like Valve's twin pointers). That means the device has to be wireless and the interface has to be voice, gaze, or mediated touch.

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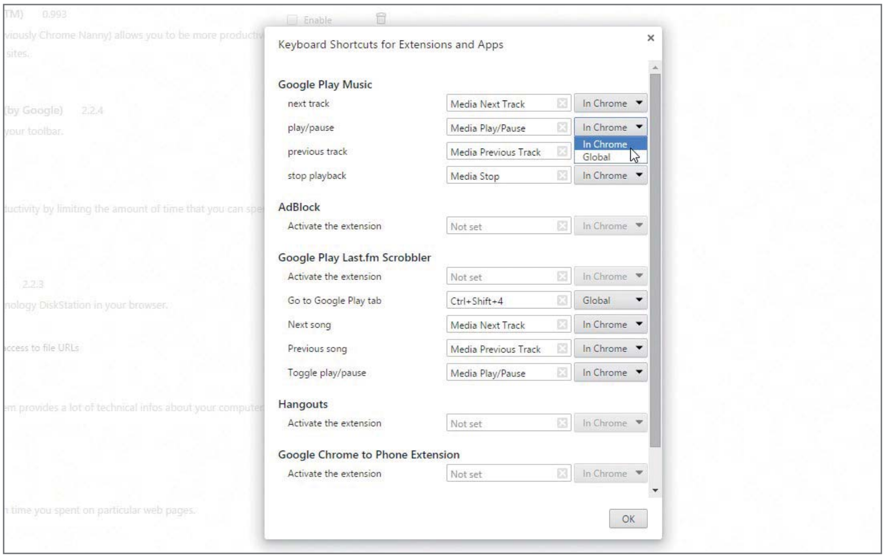
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH



Keyboard Shortcuts for Extensions and Apps

Google Play Music

next track	Media Next Track	In Chrome
play/pause	Media Play/Pause	In Chrome
previous track	Media Previous Track	
stop playback	Media Stop	In Chrome

AdBlock

Activate the extension	Not set	In Chrome

Google Play Last.fm Scrobbler

Activate the extension	Not set	In Chrome
Go to Google Play tab	Ctrl+Shift+4	Global
Next song	Media Next Track	In Chrome
Previous song	Media Previous Track	In Chrome
Toggle play/pause	Media Play/Pause	In Chrome

Hangouts

Activate the extension	Not set	In Chrome

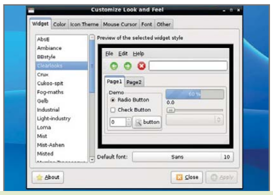
Google Chrome to Phone Extension

Activate the extension	Not set	In Chrome

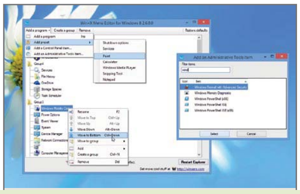
TAKE CONTROL OF YOUR MEDIA KEYS

If you've got the Chrome browser installed, your keyboard's media keys might not work, due to them being hijacked to only work with Google's Play Music. It's easy to fix. Open Chrome, click the menu icon in the upper right, choose "More tools," then "Extensions." Click "Keyboard shortcuts" and change the Google Play Music settings from "Global" to "In Chrome."

MAKE – USE – CREATE



60
Install Linux on your Chromebook



64
Become a Win8 Power User

68
Build an extra quiet mid-tower rig

GRAHAM BARLOW
CONTRIBUTING EDITOR

STAND UP FOR APPLE WATCH

Stand up! No, really. Do it. It could save your life. Like most people, you probably thought the new Apple Watch's much-touted ability to remind you to stand up every hour was a joke, but it turns out to be based on some reliable stats.

If you use a PC at work, you're probably sitting for up to eight hours a day. Throw in the time you're commuting, or reading this magazine, and your amount of sedentary behavior is hitting dangerous levels.

It's said the obese sit for 2.5 hours longer than "regular" people per day, and new office workers have been shown to gain a hefty 16lb within the first 10 months of starting a job. But once you're standing, you're burning more calories and you might even move around more.

But there's no need to throw $10,000 at Apple for the privilege of wearing a gold-plated nagging device. There are plenty of free PC programs that will remind you when to stand, like the Varidesk app (www.varidesk.com). Or, if you want to go low-fi, just set up a series of alarms on your phone. In fact, you can start right now. Go on, take a trip to the kitchen. It might just save your life.

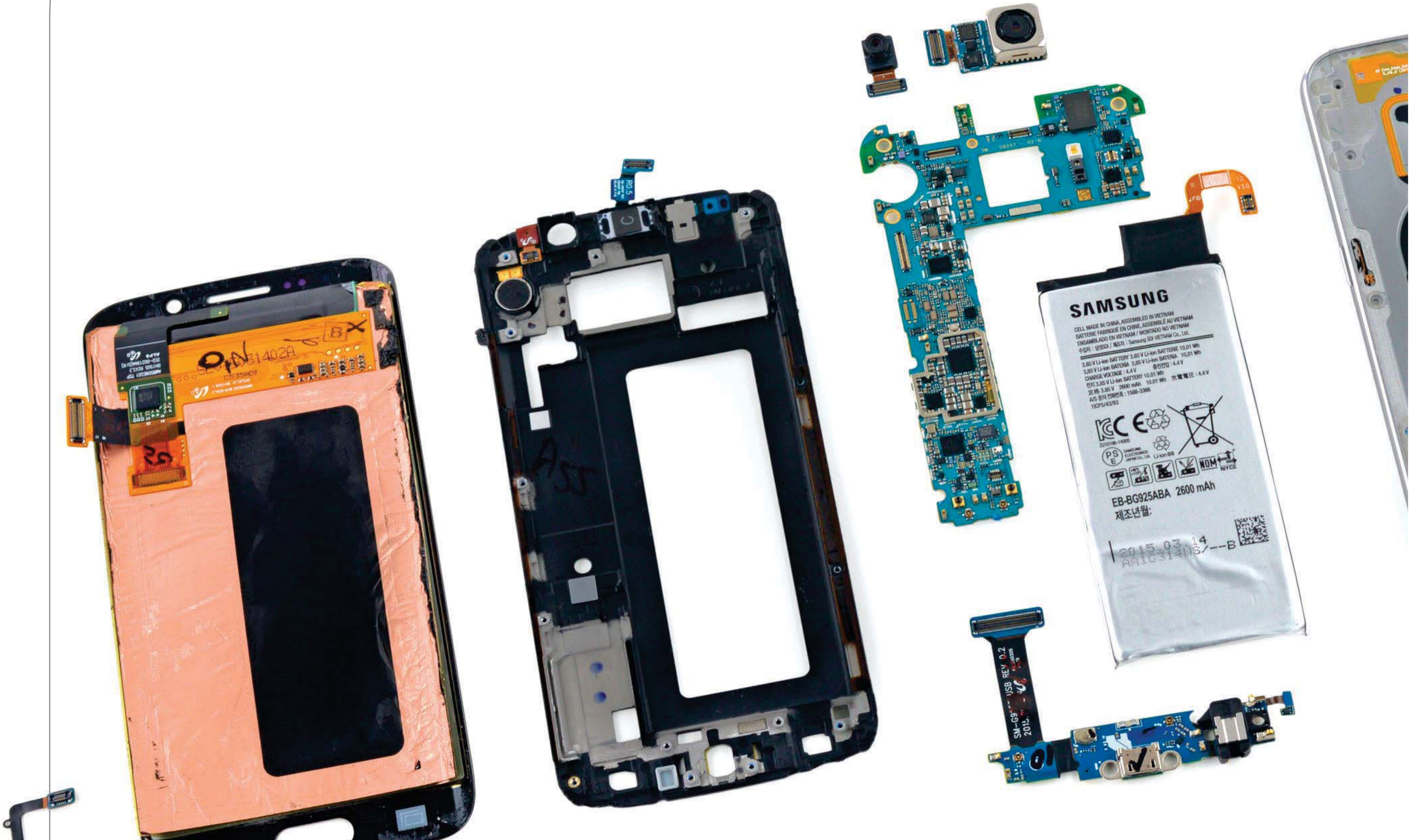
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Galaxy S6 Edge



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

A glass back and a stubbornly glued battery is very Apple-like. Sadly, there's no Apple-style pull tabs in sight.

It looks great, is powerful, and has a good camera, but in some ways, the S6 Edge has gone backward.

SAMSUNG
Galaxy S6 edge
Z-N4
ZE-KOR

It bends! Super AMOLED screens allow for thinner form factors, but beware, they can have shorter lives.

BACKGROUND:

With its glass-and-aluminum construction and curved-edge screen, Samsung looks to have leaped light-years ahead with its newest flagship smartphone, the Galaxy S6 Edge. But is it as future-proof as it is futuristic. Only a teardown will tell...

MAJOR TECH SPECS:

- 5.1-inch Super AMOLED capacitive touchscreen (1440x2560, 16M colors)
- Samsung Exynos 7 Octa 7420 Processor, integrated Mali-T760 GPU and 3GB memory
- 16MP rear camera with HDR, LED Flash, and 4K video recording
- Built-in support for Qi and Powermat wireless charging
- 32/64/128 GB storage options (but no microSD slot)

KEY FINDINGS:

- The rear panel is glued on rock-solid. We had to break out a suction cup to slip in an opening pick. Definitely not fun. With the panel finally off, the adhesive peels off the glass nicely, but leaves a sticky residue on the metal midframe.
- Using a screwdriver and plastic opening tool, the midframe comes off easily, revealing all the goodies. But the battery is still held captive under the mobo. We'd normally remove the MicroSD card now. Oh, that's right—Samsung eliminated it. If you need extra storage, you'll need to pay for it up-front.
- We pluck out the main camera to get a better look at the hardware. The 16MP OIS rear-facing camera dwarfs the 5MP selfie cam. On the front we find: Samsung Exynos 7420 Octa-core Processor (64-bit), 2.1GHz Quad + 1.5GHz Quad, along with Samsung K3RG3G30MM-DGCH 3GB LPDDR4 RAM, and Samsung KLUBG4G1BD 32GB NAND Flash.
- A glass back and a stubbornly glued battery? Samsung, have you been hanging out with Apple? Finally free, we get a better look at the 3.85V, 10.01Wh battery. Samsung has returned to a 2,600mAh battery, like the S4.
- In what seems another step backward, the S6 dumps the S5's lightning-fast Micro-B USB 3.0 port for a microUSB (2.0) port. Apart from saving some space, we fail to see the point.
- The Super AMOLED display is what allows for the smooth curves. Riding on the back of the display is the customary touchscreen controller, this time an STMicro FT6BH.
- Repairability Score: 3 out of 10 (10 is easiest to repair). Many components are modular. In an improvement over the S5, you no longer have to remove the display to get into the phone and replace the mobo. Front and back glass makes for double the crackability, and strong adhesive makes it hard to gain entry. The battery is very tightly adhered, and buried beneath the midframe and motherboard. Replacing the glass without destroying the display is going to be very difficult.

Install Linux on a Chromebook

YOU'LL NEED THIS

CROUTON
The free installer is a gateway to a Linux OS. Download it from http://goo.gl/fd3zc.

USB STICK
You'll need to back up your OS to a USB stick or SD card before getting started—2GB should be enough.

CHROME OS IS BRILLIANT. For the type of user Chromebooks are generally aimed at, it does exactly what it needs to do. It's fast and easy to use—what more could you ask for? Well, you may find yourself missing some of the features associated with more traditional operating systems. Don't worry, help is at hand, in the form of Crouton.

Crouton is a set of programs that create a chroot environment within Chrome OS, from which you can run a Linux OS, with Debian and Ubuntu currently supported. A chroot is not the same as a virtual machine—you're still running on the standard OS, but within a new environment. This has several advantages. It doesn't touch the existing OS installation, making reversal easy; it uses the Chrome OS drivers, so there are no compatibility issues; and it's written by the Chrome OS authors, so it should remain compatible with future updates. The only real disadvantage is there may be a slight performance hit, but you didn't buy a Chromebook for its blazing speed. Read on to learn how to get an assortment of Linux distros up and running. –NEIL BOTHWICK

1 CREATE A RESCUE DISK

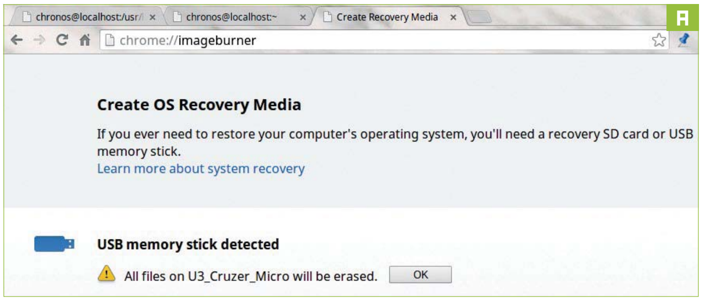
Before you start installing another OS, it's a good idea to create a rescue disk to restore your Chromebook should anything go wrong. Even if you're not installing another OS, this is a wise step to take, especially as it's so simple. All you need is a USB stick or SD card with a capacity of at least 2GB. Because of the cloud-based nature of Chrome OS, 2GB is enough, because you only need to back up the operating system—your data and settings are safe on Google's servers.

» Plug in the USB stick or SD card, open Chrome, and type chrome://imageburner into the location bar [**Image A**]. Chrome OS downloads and installs the recovery image for your Chromebook. If you've more than one Chromebook, run this separately for each one. After downloading, the image is written to your USB stick. If you don't create a recovery disk, it's also possible to get this image from another computer and copy it manually, by following the instructions at http://bit.ly/1zSC3xr, but you have to make sure you get the right image—they're specific to each model.

» If you manage to corrupt Chrome OS and get the scary "Chrome OS is missing or damaged" message, plug in your recovery medium. You can also force a recovery, if you want to go ahead and restore it anyway, by pressing the hard reset button or key combination, which varies from model to model. Check your Chromebook's documentation for whatever applies [**Image B**].

2 ACTIVATE DEVELOPER MODE

Using Crouton means putting your Chromebook into Developer Mode first, which means you get root access, and even a Bash shell. This isn't a hack. It's a fully supported, if hidden, official option. A warning to start with—enabling Developer Mode wipes your storage. It doesn't affect your cloud storage, but any files stored locally should be uploaded to Google Drive before you proceed.



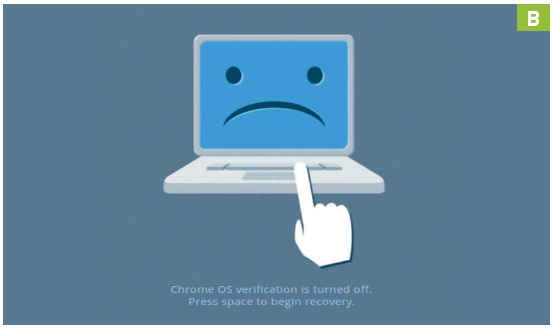
Create OS Recovery Media

If you ever need to restore your computer's operating system, you'll need a recovery SD card or USB memory stick.

Learn more about system recovery

USB memory stick detected

All files on U3_Cruzer_Micro will be erased.



Chrome OS verification is turned off.
Press space to begin recovery.

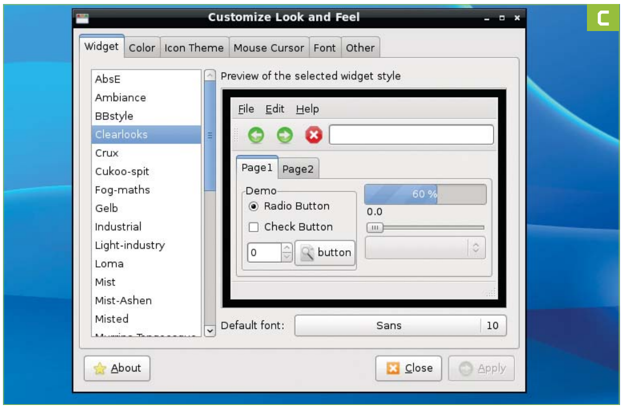
» The method of enabling Developer Mode is device-specific, so find instructions at the Chromium website: http://bit.ly/1gDHPGd. On the Acer C720 we used for testing, as with most Samsung devices, you turn the device off and then hold down the Escape and Refresh keys before pressing the power button. This gets you into the recovery screen, then press Ctrl–D to enable Developer Mode. Other devices have a hardware button for this.

» Once Developer Mode is enabled, you'll see the "OS verification is OFF" screen each time you turn on—press Ctrl–D to continue booting, or wait 30 seconds.

3 INSTALL CROUTON

When you're ready, start downloading Crouton from http://goo.gl/fd3zc. This is a script that downloads and installs everything you need. You run it from a shell—yes, Chromebooks come with a shell. Press Ctrl–Alt–T to open the Crosh shell in a browser tab.

» This is a limited shell and Crouton needs to know which distro you want to install; it calls these releases and selects them with the "-r" option. Then it needs to know the target environment you want to install. A target is a collection of software packages, such as a particular desktop. These two commands will list the options:



```
sh -e ~/Downloads/crouton -r list
sh -e ~/Downloads/crouton -t list 2→&1 | more
```

» The second command needs to be passed to "more" because it is several screenfuls—hit Space to page through them all. Once you've decided the release and target you want, you can run Crouton. To install Ubuntu 13.10 (Saucy Salamander) with the Unity desktop, for example, run:

```
sudo sh -e ~/Downloads/crouton -r saucy -t unity
```

» This uses "sudo" because you need root to install the software. You can also specify multiple targets, like this example that installs Debian Wheezy with the LXDE desktop [**Image C**] and the XBMC media center:

```
sudo sh -e ~/Downloads/crouton -r \wheezy -t lxde,xmbc
```

4 STARTING UP

Depending on the target(s) selected and the speed of your Internet connection, this could take a while. When it's finished, it tells you the command needed to start your chosen distro in the chroot, such as:

```
sudo startunity
```

» Run that command and you'll be in a standard Ubuntu desktop. When you've finished, log out in the usual way, and you go back to the familiar Chrome OS. You can switch between the two by holding Ctrl–Alt–Shift and pressing Forward or Back, too. In fact, the Chrome OS navigation keys above the numeric row are treated as the F keys by Linux, so these are really Ctrl–Alt–Shift–F1 and Ctrl–Alt–Shift–F2.

» The installation you end up with is not the complete distro as you would get if you'd installed it natively, but any extra packages can be installed in the usual way. If using Unity [**Image D**], the Software Center is not installed, so open a terminal in Unity, Ctrl–Alt–T, and run:

```
sudo apt-get update
sudo apt-get install software-center
```

» Now you can install any other packages you need from the GUI. You can also install extra target environments with the "-u" flag. For example, to add the LXDE environment to the Ubuntu chroot we created before, we'd run:

```
sudo sh -e ~/Downloads/crouton -r saucy -u -t lxde
```

5 ADDING PRIVACY

As you may have noticed, enabling Developer Mode gives you root access through "sudo," without requiring a password. This is slightly less secure for Chrome OS.

» Your login and files are still protected by your Google login, but it means all the files in your chroot are readable, even with a passwordless guest login. If this concerns you, it's possible to encrypt the entire chroot by using the "-e" flag for Crouton. This prompts for a password and uses that to encrypt the entire chroot directory, meaning you can neither read nor run the chroot without the password. For example:

```
sudo sh -e ~/Downloads/crouton -e -r wheezy -t xfce
```

» There are lots of distribution releases and targets to choose from; you could install them all at once, but that would get pretty bloated, so how do you try them all out?

» The answer is you can have as many chroots as you have space for. If you plan to do this, you may find it easier to use Crouton's "-n" option to give each chroot a name, otherwise they're simply named after the release. Naming is important when installing multiple releases because the

CROUTON: PROS AND CONS

Comparing a cheap Chromebook to a full laptop may seem unfair, but we'll do that anyway. Running Ubuntu or Debian on a Chromebook is just like running it on a proper laptop.

The only differences are down to the use of a chroot and the scary boot messages you get. This means you have to boot into Chrome OS first and then open a shell to start the chrooted session. But Chromebooks are designed to be suspended rather than shut down, so this isn't necessary often. It uses the hardware through Chrome OS, so you need to do things like set up your network connection in there, but as you can switch between the OSes at will, this isn't a problem. It's not dual boot, it's running both at once. Far more convenient.

The main limitation is the lack of storage space and dependence on a network connection and cloud services. While Chrome OS handles this transparently, you need to set up some sort of online syncing from your chrooted distro, using services such as OwnCloud, Spideroak, or Dropbox.

There are other ways of installing Linux on a Chromebook, but Crouton does it in the least intrusive way, leaving your existing operating system untouched (apart from needing to enable Developer Mode). You can also try multiple distros, and remove them when done, which is also a key benefit of this approach. A real strength of Crouton is that it's developed by the Chrome OS authors themselves—it's not a third-party hack. This means that future updates to Chrome OS could potentially break your chroots temporarily, but a quick update through Crouton should fix it.

name is needed when running the startup commands, otherwise Crouton just loads the first release in which it finds the target you gave. Adding "-n," like this, ensure you load the right release:

```
sudo startunity -n saucy
```

» Crouton also installs a couple of useful tools, particularly "edit-chroot." This can be used to back up a chroot.

```
sudo edit-chroot -b saucy
```

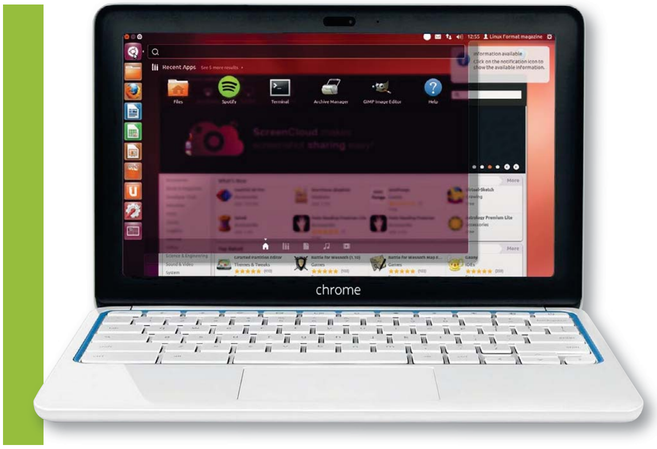
» This creates a backup file in "~/Downloads," which you can restore with the following:

```
sudo edit-chroot -r ~/Downloads/backup-file.tar.gz
```

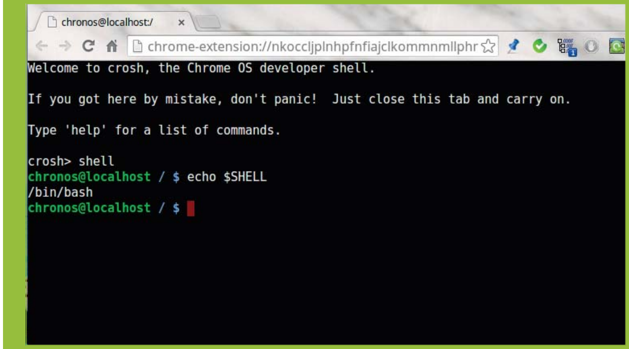
» Copy this somewhere safe. Even if you do a full reset/recovery, you can still restore it by downloading Crouton again and running:

```
sudo sh -e ~/Downloads/crouton -f backup-file.tar.gz
```

» You can also use "delete-chroot" to delete a chroot, which you could probably have worked out, or you can delete the directory holding it from "/usr/local/chroots" and go back to a vanilla Chrome OS. Assuming, of course, that you'd want to do that.



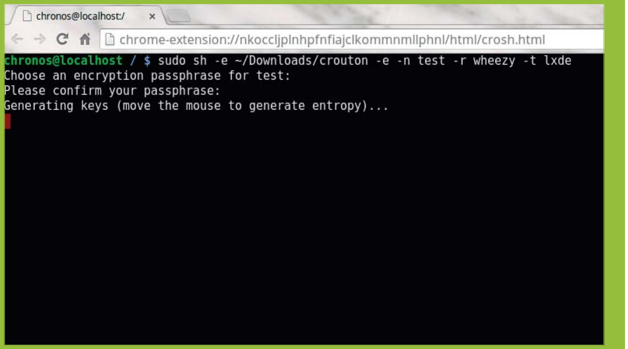
INSTALL A RELEASE


chronos@localhost:/
chrome-extension://nkoccljplnhpfnfiajclkommnmllphr

```
Welcome to crosh, the Chrome OS developer shell.

If you got here by mistake, don't panic!  Just close this tab and carry on.

Type 'help' for a list of commands.

crosh> shell
chronos@localhost / $ echo $SHELL
/bin/bash
chronos@localhost / $
```

1. OPEN A SHELL AND CHOOSE A RELEASE

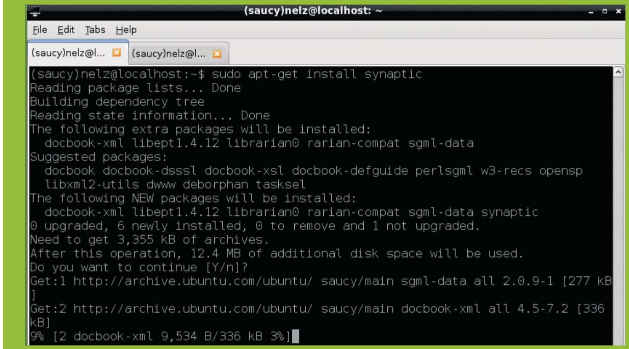
Open a terminal window by pressing Ctrl–Alt–T. You can see the set of commands by typing "list." One of the commands is "shell," which gives you a full Bash shell (patched for Shellshock). Run Crouton with "-t" to see all the available targets. Chromebooks are relatively low-powered, and a lightweight desktop such as LXDE is a good choice. Unity is better suited to running everything full-screen.


chronos@localhost:/
chrome-extension://nkoccljplnhpfnfiajclkommnmllphnl/html/crosh.html

```
chronos@localhost / $ sudo sh -e ~/Downloads/crouton -e -n test -r wheezy -t lxde
Choose an encryption passphrase for test:
Please confirm your passphrase:
Generating keys (move the mouse to generate entropy)...
```

2. ENCRYPT YOUR FILES AND INSTALL THE DISTRO

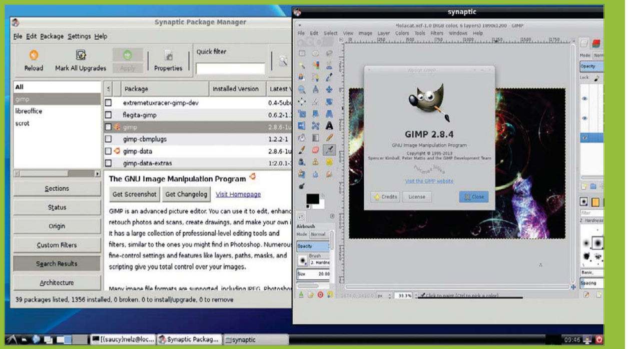
Adding "-e" to Crouton's command line causes your chroot to be stored in an encrypted directory (this isn't the same as the "e" that follows "sh"). Choose a decent passphrase, but remember most of your data will be saved in the cloud because Chromebooks have very little storage. Crouton is only an installer, so it needs to download the distro release files before installing. Even with a fast connection, it can take 30 minutes.


(saucy)nelz@localhost: ~
File
Edit
Tabs
Help
(saucy)nelz@l...
(saucy)nelz@l...

```
(saucy)nelz@localhost:~$ sudo apt-get install synaptic
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following extra packages will be installed:
  docbook-xml libept1.4.12 librarian0 rarian-compat sgml-data
Suggested packages:
  docbook docbook-dsssl docbook-xsl docbook-defguide perlsgml w3-recs opensp
  libxml2-utils dwww deborphan tasksel
The following NEW packages will be installed:
  docbook-xml libept1.4.12 librarian0 rarian-compat sgml-data synaptic
0 upgraded, 6 newly installed, 0 to remove and 1 not upgraded.
Need to get 3,355 kB of archives.
After this operation, 12.4 MB of additional disk space will be used.
Do you want to continue [Y/n]?
Get:1 http://archive.ubuntu.com/ubuntu/ saucy/main sgml-data all 2.0.9-1 [277 kB
]
Get:2 http://archive.ubuntu.com/ubuntu/ saucy/main docbook-xml all 4.5-7.2 [336
kB]
9% [2 docbook-xml 9,534 B/336 kB 3%]
```

3. ADD A PACKAGE MANAGER

The default targets include only the command line package manager, "apt-get." For most people, the first step is to open a terminal and use it to install a more friendly option, such as "software-center" for Ubuntu, or "Synaptic" for Ubuntu and Debian. Run "sudo apt-get update" to make sure you get the current version, then "sudo apt-get synaptic."


Synaptic Package Manager
File
Edit
Package
Settings
Help
Reload
Mark All Upgrades
Apply
Properties
Quick filter
All
gimp
libreoffice
scrot
Sections
Status
Origin
Custom Filters
Search Results
Architecture
Get Screenshot
Get Changelog
Visit Homepage
synaptic
GIMP 2.8.4
GNU Image Manipulation Program
Credits
License
Close

S	Package	Installed Version	Latest V
☐	extremetuxracer-gimp-dev		0.4-5ubu
☐	flegita-gimp		0.6.2-1.1
☐	gimp	2.8.6-1u	
☐	gimp-cbmplugs		1.2.2-1
☐	gimp-data	2.8.6-1u	
☐	gimp-data-extras		1:2.0.1-3

The GNU Image Manipulation Program

GIMP is an advanced picture editor. You can use it to edit, enhanc retouch photos and scans, create drawings, and make your own i It has a large collection of professional-level editing tools and filters, similar to the ones you might find in Photoshop. Numerou fine-control settings and features like layers, paths, masks, and scripting give you total control over your images.

39 packages listed, 1356 installed, 0 broken. 0 to install/upgrade, 0 to remove

4. RUN SYNAPTIC

Once you've Synaptic installed, you have easy access to all the software in a distro's repository. Most of the targets are slimmed down, to save on downloads and give a faster installation, but you can install anything you want from here. Either use the "Search" button or just browse the categories to see what's available.

Configure your Second Display

YOU'LL NEED THIS

SECOND SCREEN
Whether it's a laptop, monitor, or TV, it should be easy to connect with either HDMI or VGA.

LIKE IT OR NOT, the most ergonomic way of using a laptop is to sit at a proper desk with a proper monitor, mouse, and keyboard. There are other advantages to this setup, as well; you can use your original laptop display as a second screen. Dual-screen setups are now the norm in many offices, and you can have the same at home as well. It's useful for copying information between documents, having your email on one screen while you work on the other, editing photos on one screen while you have your photo library on the other, and so on. Here we'll set up Windows to function with a second screen and configure the two screens to be set up the way you want. Likewise, this tutorial will also help you if you have a work laptop that you often plug into different screens, perhaps in meeting rooms or out on the road. **–DAN GRABHAM**

1 GO TO THE DISPLAY CHARM

Once you've physically connected your main display (via HDMI or VGA), your second screen will show the same as your first screen or it will be blank. You may want the same thing on both screens, but we're going to extend the desktop. In Windows 8 or 8.1, push your mouse to the right-hand side of the screen to show the Charms menu. Select "Devices."

2 PROJECT YOUR SCREEN

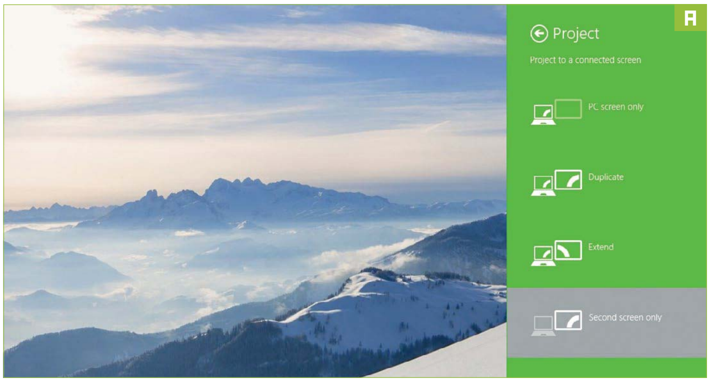
The Devices menu shows three options: Play, Print, and Project. Select "Project." This is the option to choose whatever type of display you're throwing your screen image to, whether it's a projector, monitor, or TV. You'll then see the next screen, which shows four display options. During this process, your main screen may flicker on and off.

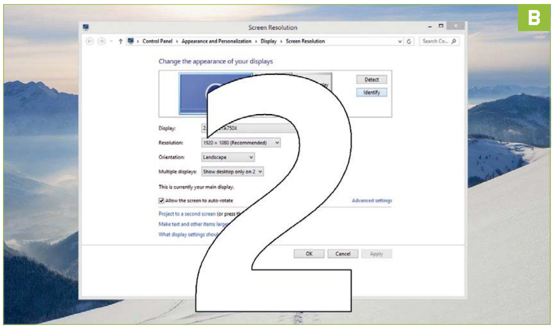
3 CHOOSE YOUR MODE

You're probably currently in Duplicate mode, but "Extend" is a better option. It enables you to extend your desktop across multiple screens. In Windows 8.1, you can have different Windows apps on the two displays. "PC screen only" turns off the signal to your second display and "Second screen only" does the opposite [**Image A**]. It's ideal for saving power on your laptop, for example.

4 CONFIRM YOUR CHOICE

We've chosen to use the second screen only. Windows will ask you to confirm. That's because there's a risk with some options you might not be able to see anything. This is a failsafe in case your main display is turned off and there's a problem with your second display. If you don't click "Yes" to confirm this option, Windows will revert to your previous display.




B
Screen Resolution
Control Panel › Appearance and Personalization › Display › Screen Resolution
Search Co...
Detect
Identify
Advanced settings
Project to a second screen (or press th
Make text and other items large
What display settings shou
OK
Cancel
Apply
2

Change the appearance of your displays

Display: 2. ...A750X
Resolution: 1920 × 1080 (Recommended)
Orientation: Landscape
Multiple displays: Show desktop only on 2

This is currently your main display.

☑ Allow the screen to auto-rotate

5 CONTROL PANEL ALTERNATIVE

You're able to perform these same actions (and more) using the Display applet. The way this works is similar to how it works in Windows 7, Vista, and XP, though some refinements have been made in Windows 8 and Windows 8.1. Navigate to it by going to "Control Panel → Appearance and Personalization → Display," and clicking on "Adjust screen resolution."

6 TOGGLE BETWEEN DISPLAYS

The Display applet features a graphical representation of the screens connected to your PC, plus some options. Here you can toggle between two connected displays. You can also change the resolution—your PC will normally automatically adjust this to suit—as well as the orientation of the desktop in case you rotate your monitor.

7 IDENTIFY YOUR DISPLAYS

If you've lost track of which display is which, click "Identify." You'll see a number on each screen [**Image B**]. Using the graphic, you can also drag the displays around so Windows knows where they are in relation to each other. It needs to know this in case you extend the desktop—if you drag the mouse off one screen, you want it to appear in the right place on the screen next to it! If your computer hasn't found your display, click "Detect." There are then options to adjust each display however you'd like.

Become a Win 8.1 Power User

YOU'LL NEED THIS

WIN+X MENU EDITOR
Manage your shortcuts with the free, third-party tool Win+X Menu Editor. Download it at http://bit.ly/1jvITAU.

MICROSOFT CAUSED A REAL UPROAR when it dropped the Start menu from Windows 8. But arguably the biggest mistake it made was failing to advertise that it had provided a replacement. Of sorts. All you needed to do was find it. The Power User Menu may not have the functionality of the original Start menu, but that doesn't make it any less useful. Indeed, even if you've installed a third-party Start menu replacement, such as ClassicShell's Classic Start Menu, you'll still find the Power User Menu incredibly handy.

As its name implies, the Power User Menu provides convenient shortcuts to key system tools, from the Program and Features Control Panel to the command prompt. In this tutorial, we'll show you how to access the Power User Menu, plus make it even better by adding your own choice of shortcuts to put any program, Control Panel, or system tool at your fingertips. **–NICK PEERS**

1 ACCESS AND USE

The Power User Menu is accessible from the desktop and the Start screen. If you haven't installed a replacement Start menu, access it by right-clicking the Start button. You can also reach it by holding Windows and pressing X. Click a menu item to launch that shortcut, or click off it to hide it.

2 RESTORE RIGHT-CLICK

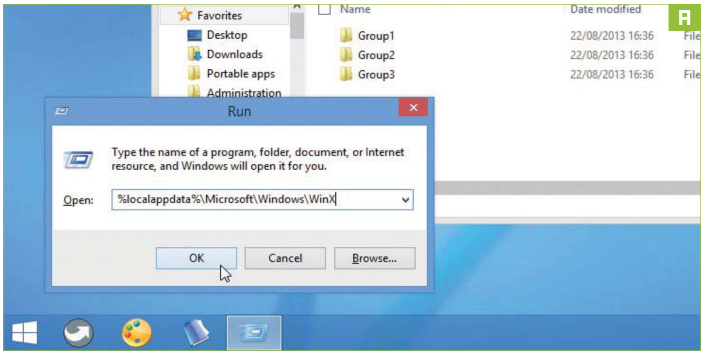
If you've installed Classic Start Menu, right-clicking the Start button won't access the Power User Menu. Instead, hold Shift and right-click the Start button, or change Classic Start Menu's default behavior. When you right-click the Start menu, choose "Settings." Tick "Show all settings," go to the Controls tab and tick "Right click opens Win+X menu."

3 MAKE CHANGES MANUALLY

To remove any unwanted shortcuts from the menu, press Windows and R to launch the Run dialog box. Type "%localappdata%\Microsoft\Windows\WinX" and hit Enter. You'll see three folders: Group1, Group2, and Group3 [**Image A**]. Each folder contains shortcuts from one section of the menu, with Group1 at the bottom, Group2 in the middle, and Group3 at the top.

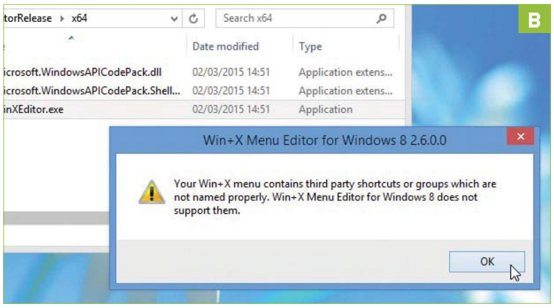
4 DELETE SHORTCUTS

Drag unwanted shortcuts to the Recycle Bin—the changes won't be applied until you log off and back on to your user account, or restart your PC. It's not possible to simply add shortcuts to these folders using the manual method—they simply won't show up in the Power User Menu.


A
Favorites
Desktop
Downloads
Portable apps
Administration
Name
Date modified
Group1 22/08/2013 16:36 File
Group2 22/08/2013 16:36 File
Group3 22/08/2013 16:36 File
Run
OK
Cancel
Browse...

Type the name of a program, folder, document, or Internet resource, and Windows will open it for you.

Open: %localappdata%\Microsoft\Windows\WinX


B
torRelease › x64
Search x64
Date modified
Type
icrosoft.WindowsAPICodePack.dll 02/03/2015 14:51 Application extens...
icrosoft.WindowsAPICodePack.Shell... 02/03/2015 14:51 Application extens...
inXEditor.exe 02/03/2015 14:51 Application
Win+X Menu Editor for Windows 8 2.6.0.0
OK

Your Win+X menu contains third party shortcuts or groups which are not named properly. Win+X Menu Editor for Windows 8 does not support them.

5 USE A THIRD-PARTY TOOL

All is not lost though, as there's a third-party tool called Win+X Menu Editor that lets you take back control. Visit http://bit.ly/1jvITAU and hit the download link. Save WinXMenuEditorRelease.zip to your Downloads folder. Right-click the zip file and choose "Extract All," then click "Extract" to place it in your Downloads folder.

6 LAUNCH PROGRAM

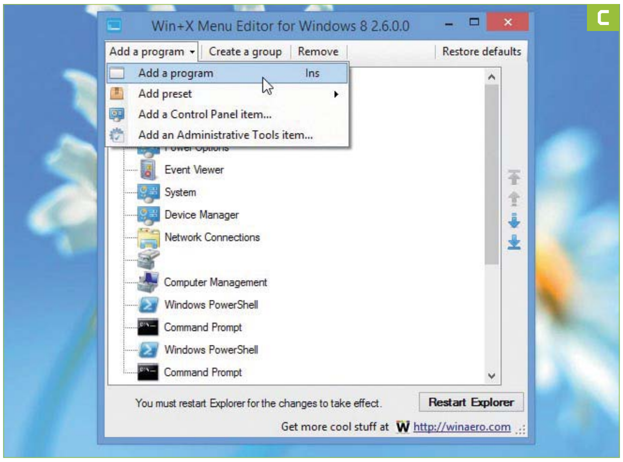
Open the WinXMenuEditorRelease folder to launch the program (unless you're running the 32-bit version of Windows 8, in which case double-click "WinXEditor"). If you've tried to add any shortcuts to these folders, you'll see a warning appear that they're not supported [**Image B**]. If this happens, click "Restore defaults" to remove them when the main window appears.

7 MANAGE EXISTING SHORTCUTS

The main program window shows existing shortcuts. Right-click one to reveal a list of options. You can remove it, rename it, or move it up and down the list to change the running order. You'll also see an option to move the shortcut to a new group.

8 ADD SHORTCUTS

Win+X Menu Editor also makes it easy to add your own shortcuts. Click the "Add a program" button to reveal four choices [**Image C**]. Select "Add a Program" again to browse for a shortcut to add to the group. Rename your shortcut if necessary, click "OK," and then right-click it to move it to where you want.

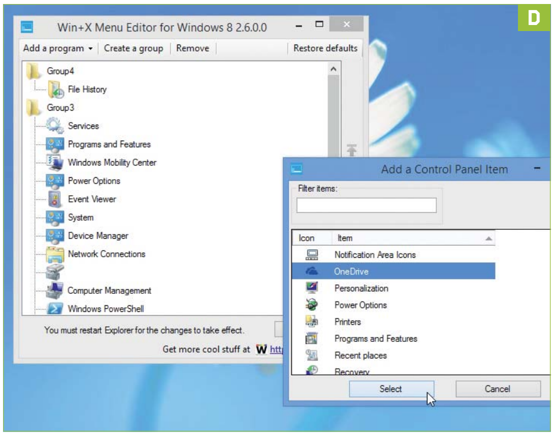

C
Win+X Menu Editor for Windows 8 2.6.0.0
Add a program
Create a group
Remove
Restore defaults
Add a program Ins
Add preset
Add a Control Panel item...
Add an Administrative Tools item...
Power Options
Event Viewer
System
Device Manager
Network Connections
Computer Management
Windows PowerShell
Command Prompt
Windows PowerShell
Command Prompt
Restart Explorer
Get more cool stuff at W http://winaero.com

You must restart Explorer for the changes to take effect.

9

ADD PRESETS

The other three options make it easy to add popular system and admin tools, as well as shortcuts to individual Control Panel applets [**Image D**]. Win+X Menu Editor also enables you to create groups—perfect for organizing your shortcuts further. Just click "Create a group" to add as many as required, then move shortcuts to them. Select a group and click "Remove" to delete it.


D
Win+X Menu Editor for Windows 8 2.6.0.0
Add a program
Create a group
Remove
Restore defaults
Group4
File History
Group3
Services
Programs and Features
Windows Mobility Center
Power Options
Event Viewer
System
Device Manager
Network Connections
Computer Management
Windows PowerShell
Get more cool stuff at W htt
Add a Control Panel Item
Filter items:
Icon
Item
Notification Area Icons
OneDrive
Personalization
Power Options
Printers
Programs and Features
Recent places
Recovery
Select
Cancel

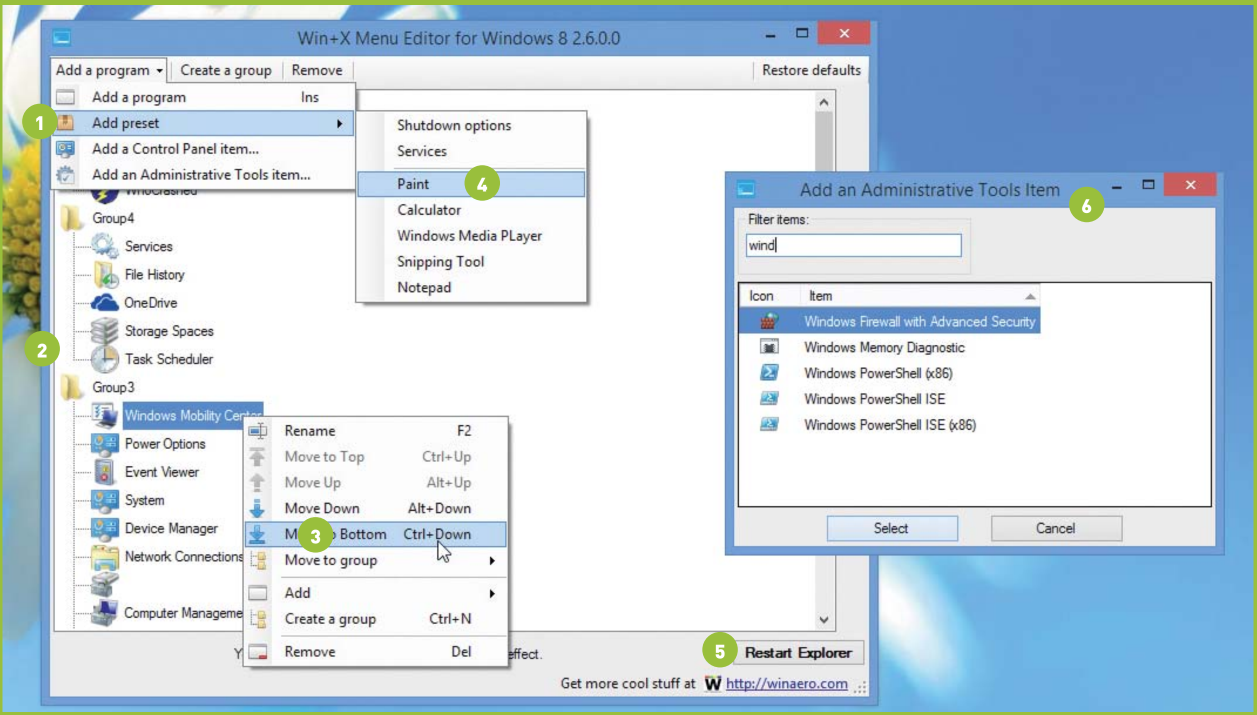
You must restart Explorer for the changes to take effect.

10

POWERED UP

Once you're happy with your changes, click the "Restart Explorer" button to enact them—once Explorer restarts, open the Power User Menu to review what you've done and make further tweaks as required. And there you go. Not only have you discovered a handy shortcuts menu, you've learned how to fine-tune it to cover your particular needs, too.

CUTTING CORNERS


Win+X Menu Editor for Windows 8 2.6.0.0
Add a program
Create a group
Remove
Restore defaults
Add a program Ins
1
Add preset
Add a Control Panel item...
Add an Administrative Tools item...
Shutdown options
Services
Paint
4
Calculator
Windows Media PLayer
Snipping Tool
Notepad
Group4
Services
File History
OneDrive
Storage Spaces
2
Task Scheduler
Group3
Windows Mobility Center
Power Options
Event Viewer
System
Device Manager
Network Connections
Computer Manageme
Rename F2
Move to Top Ctrl+Up
Move Up Alt+Up
Move Down Alt+Down
Move to Bottom Ctrl+Down
3
Move to group
Add
Create a group Ctrl+N
Remove Del
5
Restart Explorer
Get more cool stuff at W http://winaero.com
Add an Administrative Tools Item
6
Filter items:
wind
Icon
Item
Windows Firewall with Advanced Security
Windows Memory Diagnostic
Windows PowerShell (x86)
Windows PowerShell ISE
Windows PowerShell ISE (x86)
Select
Cancel

1. ADD NEW ENTRIES
The app Win+X Menu Editor makes it easy to add shortcuts to the Power User Menu. Just select a type to get started.

2. VIEW ENTRIES
All existing entries are displayed here in groups and shown in the order they appear on the actual menu.

3. MANAGE ENTRIES
Right-click an entry to reveal options to remove, rename, and reorder it. You can also move an item between groups.

4. PRESETS
Some built-in Windows apps, as well as the Services management console and shutdown options, can be added here.

5. ENABLE CHANGES
Click the "Restart Explorer" button to see the effects of your changes. Once Explorer restarts, press Win–X.

6. ADD MORE ITEMS
Go to "Control Panel" or "Administrative Tools" to pick new items from a list. Use the filter to find specific entries.

Take Control of File Explorer

YOU'LL NEED THIS

WINDOWS 8.1
File Explorer is a revamped Windows Explorer. It revolutionizes how you manage files and folders.

WINDOWS 8.1'S FILE EXPLORER is more than just a rebadged version of Windows Explorer. It's a revelation. Thanks to a raft of improvements and new features, it makes managing your files easier than ever. There's the improved file copying tool, which not only speeds up file transfers, but makes them easier to manage, too. The new ribbon-based UI places all the key tools you need within easy reach, and the Navigation pane remains a great way to quickly move to the different parts of your PC.

In this tutorial, we'll reveal File Explorer's best features, some of which are hidden away from view. We'll also show you how to make File Explorer even more useful by customizing it to your personal requirements. You'll be working smarter before you know it! **–NICK PEERS**

1 CUSTOMIZE NAVIGATION PANE

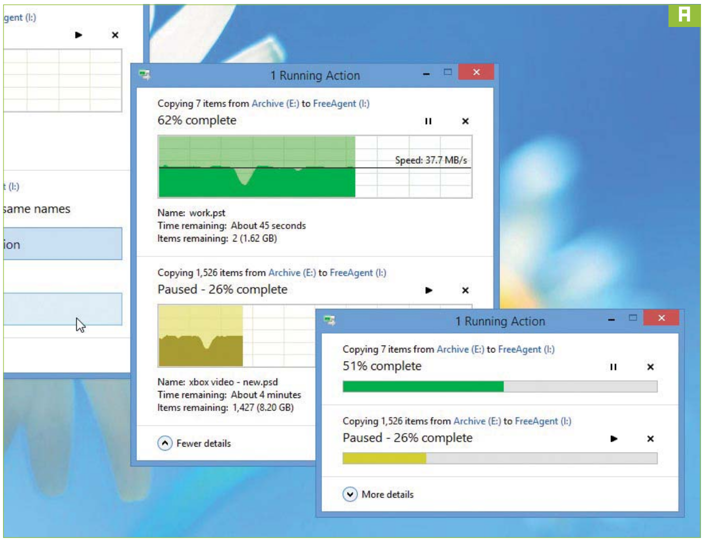
Click the "File Explorer" button on the Taskbar to open a File Explorer window. The Navigation pane on the left is designed to put frequently accessed folders and drives at your fingertips. Click "Navigation" on the "View" tab to show or hide the Favorites list, plus restore the Libraries view. Choose "Show all folders" to unite all other lists under a single Desktop view.

2 QUICK-FIRE SELECTIONS

When the "Item check boxes" box is ticked on the "View" tab, selecting a file or folder results in a box being ticked. You can choose one of two ways: Roll the mouse over an item and then click the tick box that appears, or use the old Ctrl–click method to quickly choose a host of files. Either way, it's a more elegant way of making multiple selections.

3 QUICKLY MOVE AND COPY FILES

You can, if you prefer, open two File Explorer windows (select "Open new window" on the "File" tab) for moving or copying files, but why not try this shortcut? Navigate to the "Home" tab where you'll find two buttons: "Move to" and "Copy to." Click either button to access a list of frequently used locations, or browse for a specific folder.


A
gent (I:)
t (I:)
same names
ion
1 Running Action
Speed: 37.7 MB/s
Fewer details
1 Running Action
More details

Copying 7 items from Archive (E:) to FreeAgent (I:)
62% complete

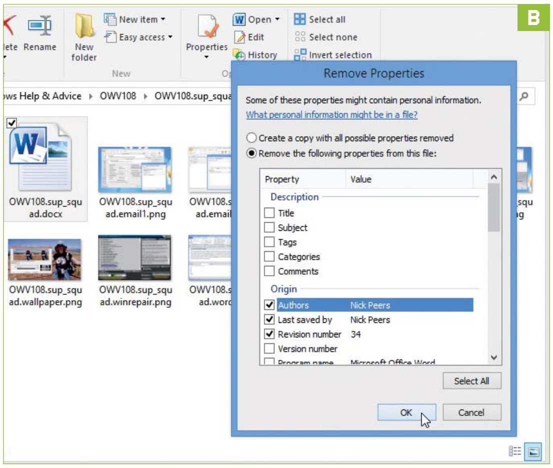
Name: work.pst
Time remaining: About 45 seconds
Items remaining: 2 (1.62 GB)

Copying 1,526 items from Archive (E:) to FreeAgent (I:)
Paused - 26% complete

Name: xbox video - new.psd
Time remaining: About 4 minutes
Items remaining: 1,427 (8.20 GB)

Copying 7 items from Archive (E:) to FreeAgent (I:)
51% complete

Copying 1,526 items from Archive (E:) to FreeAgent (I:)
Paused - 26% complete


B
lete
Rename
New folder
New item
Easy access
New
Properties
Open
Edit
History
Select all
Select none
Invert selection
ws Help & Advice
OWV108
OWV108.sup_squa
OWV108.sup_squad.docx
OWV108.sup_squad.email1.png
OWV108.s ad.email
squ g
OWV108.sup_squad.wallpaper.png
OWV108.sup_squad.winrepair.png
OWV108.s ad.word
Remove Properties
What personal information might be in a file?
Select All
OK
Cancel

Some of these properties might contain personal information.

○ Create a copy with all possible properties removed
● Remove the following properties from this file:

Property	Value
Description	
☐ Title	
☐ Subject	
☐ Tags	
☐ Categories	
☐ Comments	
Origin	
☑ Authors	Nick Peers
☑ Last saved by	Nick Peers
☑ Revision number	34
☐ Version number	
☐ Program name	Microsoft Office Word

4 FASTER, IMPROVED COPYING

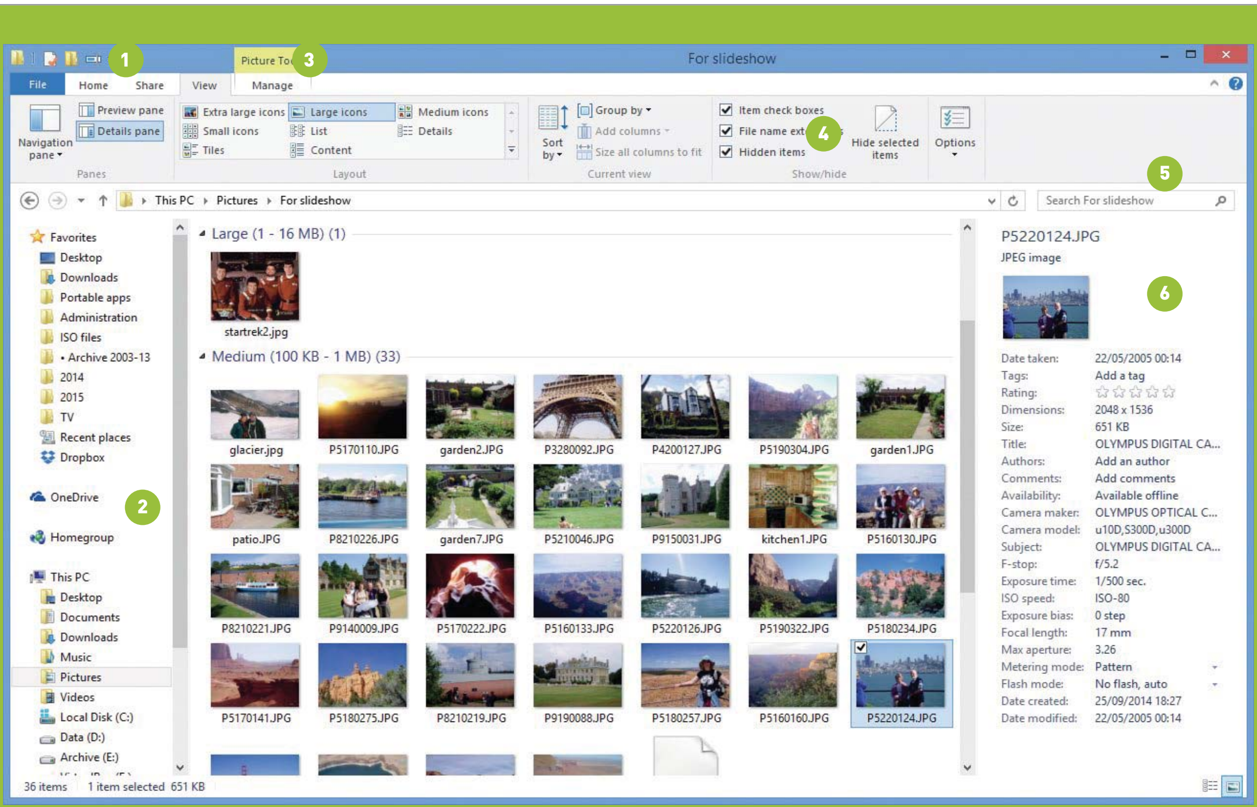
When files are being moved or copied, a new dialog provides more options, particularly when you may need to replace (or ignore) existing files. During the copy process, click the expand button to see the file transfer speeds. The new dialog also allows you to pause and resume transfers—handy when you want to suspend a large transfer operation temporarily **[Image A]**.

5 EDIT FILE PROPERTIES

Want to share a file without including all that private metadata such as its author? Select the file, then click the arrow beneath the Properties button on the Home tab, and choose "Remove properties." You can create a separate copy stripped of personal information, or select which properties to remove from the file itself—click "OK" when done **[Image B]**.

6 ROLL BACK FILES

Need access to an older version of a file? Select the file or folder in question, then click the "History" button on the Home tab. Right-click the file and choose "Preview," then use the playback controls at the bottom to locate the version you want to restore. Click the "Restore" button to overwrite the original file, or click "Settings → Restore to" to save a separate copy instead.


1
2
3
4
5
6
Picture Tools
For slideshow
File
Home
Share
View
Manage
Navigation pane
Preview pane
Details pane
Panes
Extra large icons
Large icons
Medium icons
Small icons
List
Details
Tiles
Content
Layout
Sort by
Group by
Add columns
Size all columns to fit
Current view
Item check boxes
File name extensions
Hidden items
Hide selected items
Show/hide
Options
This PC › Pictures › For slideshow
Search For slideshow
Favorites
Desktop
Downloads
Portable apps
Administration
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• Archive 2003-13
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Recent places
Dropbox
OneDrive
Homegroup
This PC
Desktop
Documents
Downloads
Music
Pictures
Videos
Local Disk (C:)
Data (D:)
Archive (E:)
Large (1 - 16 MB) (1)
startrek2.jpg
Medium (100 KB - 1 MB) (33)
glacier.jpg
P5170110.JPG
garden2.JPG
P3280092.JPG
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P8210219.JPG
P9190088.JPG
P5180257.JPG
P5160160.JPG
P5220124.JPG
36 items 1 item selected 651 KB

P5220124.JPG
JPEG image

Date taken: 22/05/2005 00:14
Tags: Add a tag
Rating: ☆☆☆☆☆
Dimensions: 2048 x 1536
Size: 651 KB
Title: OLYMPUS DIGITAL CA...
Authors: Add an author
Comments: Add comments
Availability: Available offline
Camera maker: OLYMPUS OPTICAL C...
Camera model: u10D,S300D,u300D
Subject: OLYMPUS DIGITAL CA...
F-stop: f/5.2
Exposure time: 1/500 sec.
ISO speed: ISO-80
Exposure bias: 0 step
Focal length: 17 mm
Max aperture: 3.26
Metering mode: Pattern
Flash mode: No flash, auto
Date created: 25/09/2014 18:27
Date modified: 22/05/2005 00:14

UNDER NEW MANAGEMENT

1. QUICK ACCESS TOOLBAR
Add any File Explorer button you like here for quick access. Up to six options are provided by default.

2. NAVIGATION PANE
Use the Home tab's Easy access button to add your most-used folders to the Favorites section for quick access.

3. CONTEXT-SENSITIVE TABS
These tabs appear when certain items are present. Click a file or folder to access context-sensitive controls.

4. VIEW TAB
Use the View tab to set up how the current folder looks and behaves. Changes will only apply to this folder.

5. SEARCH
Type search terms here to look through the current folder. Use the ribbon's Search tab to fine-tune the results.

6. DETAILS PANE
Selecting this and clicking a file or folder reveals its details without having to manually open its Properties box.

7 CUSTOMIZE SEARCHES

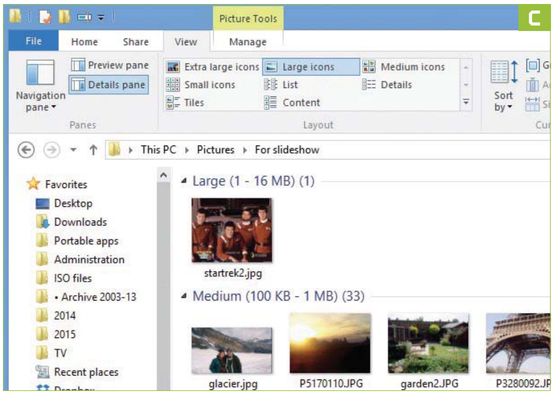
Enter your search terms into the Search box and hit Enter—a new Search Tools tab will appear. Use this to change the location of the search, plus refine the search terms using filters such as type of file, size, and when it was last modified. You can also access recent searches, change which folders are indexed via the "Advanced options" button, and save your search.

8 SHARING OPTIONS

The Share tab contains more than just the usual options. This is where you go when you want to burn selected files to disc, print or fax them, add them as an attachment to an email, or compress them into a Zip file. An "Advanced security" button is also here if you need to fine-tune access permissions.

9 QUICK ACCESS TOOLBAR

You can add any File Explorer item you'd like to the Quick Access Toolbar by right-clicking its button and then choosing "Add to Quick Access Toolbar." There's space to display up to seven items above the ribbon on the Toolbar. Alternatively, you can click the "Customize" button and choose "Show below the ribbon" to give it some more room. Manage the Toolbar by right-clicking unwanted items and choosing the "Remove" option.


C
Picture Tools
File
Home
Share
View
Manage
Navigation pane
Preview pane
Details pane
Panes
Extra large icons
Large icons
Medium icons
Small icons
List
Details
Tiles
Content
Layout
Sort by
This PC › Pictures › For slideshow
Favorites
Desktop
Downloads
Portable apps
Administration
ISO files
• Archive 2003-13
2014
2015
TV
Recent places
Large (1 - 16 MB) (1)
startrek2.jpg
Medium (100 KB - 1 MB) (33)
glacier.jpg
P5170110.JPG
garden2.JPG

10 HIDE THE RIBBON

The ribbon user interface at the top displays a series of toolbars in separate tabs, instead of a more traditional menu-based system. If it's not to your taste, click the ^ button in the top right-hand corner. That hides everything except the tabs and the Quick Access Toolbar. Click a heading to view the options for that tab—when you click away from the ribbon it'll disappear. Restore it by hitting the down arrow button **[Image C]**. ⏻

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Twice as Nice: Quietly Does It

Fitting multiple radiators into a new mid-tower case from Fractal Design

LENGTH OF TIME: **1–3 HOURS** LEVEL OF DIFFICULTY: **MEDIUM**

THE MISSION

WHEN THIS EDITOR took over the "Build It" section a couple of years ago, the aims were initially modest: Don't screw it up. The standards were high, and the amount of available time was low—just the way we like it. It turned necessity into the mother of invention, leading to a PC running inside an aquarium filled with mineral oil, a mini Dream Machine cramming a 280mm radiator and dual videocards into a microATX case, a tri-SLI 4K test bench, and everything in between.

In this final entry before the reins are handed off to another gearhead, we come full circle and do something relatively straightforward: a nice gaming system that doesn't break the bank, built inside a relatively conventional mid-tower case. But there's some new and interesting hardware in the mix, of course—expect nothing less. We have minty-fresh gear from Fractal Design, Corsair, and Asus for your perusal. This build is also oriented toward low noise, so those of you with sensitive ears might want to check it out.

NOT LOUD, STILL PROUD

WHEN YOU'RE TRYING to cut down on noise generation, the biggest factor is your case. Fractal Design recently released the Define R5, which is a mid-tower with pre-installed noise absorption panels on the sides and front. The top of it uses the company's "ModuVent" system, which features modular panels with their own sound absorption that you can pop out to mount fans. We've had great success in the noise department with the R4, and this line of cases is quite roomy and sturdily built as well. Perfect for our needs.

The funky-looking videocard in there is the Radeon R9 295X2. This has two 290X GPUs in it, and an integrated water-cooling system with a 120mm radiator and fan. We moved some things around to make room for its cooling. Since it only costs around $650, despite being the fastest single card available (Nvidia's Titan Z was apparently a limited run), it seemed like a no-brainer.

Of course, he needs some hefty power, so we're adding our trusty 800W Cooler Master Silent Pro Gold. This—along with an Intel Core i7-4790K, 2x 4GB of low-profile Corsair DDR3 RAM, a 480GB SanDisk Extreme II SSD, and a 4TB WD Black Edition—gets plugged into an Asus Z97 Pro Gamer motherboard, which we should be able to overclock respectably. We've also added a 120mm Noctua fan to the front of the case. Otherwise, we'd have just the one 140mm pre-installed fan in that spot.

INGREDIENTS

PART		PRICE
Case	Fractal Design Define R5	$110
PSU	Cooler Master Silent Pro Gold 800W	$130
Mobo	Asus Z97 Pro Gamer	$160
CPU	Intel Core i7-4790K 4GHz	$340
GPU	AMD Radeon R9 295X2	$650
RAM	2x 4GB low-profile Corsair DDR3	$60
SSD	SanDisk Extreme II 480GB	$440
HDD	Western Digital Black 4TB	$213
OS	Windows 8.1 64-bit OEM	$100
Total		$2,203

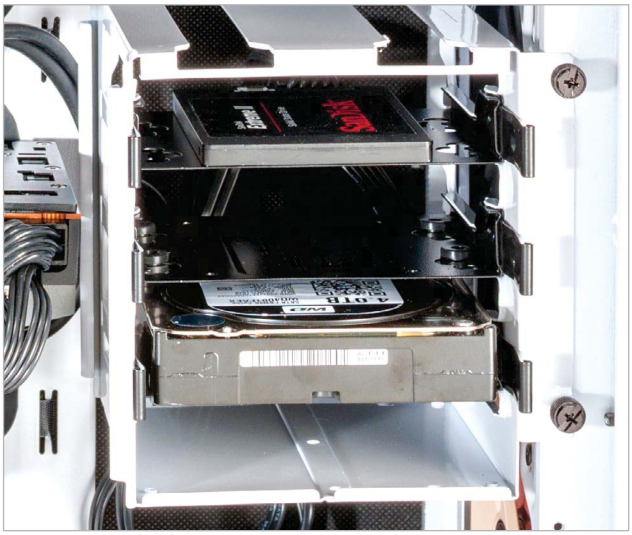
1 PANEL BEATING

THIS SWITCH IS NEW to Fractal Design cases. When you press down, it releases two catches that hold the side panel onto the case. That means you have toolless entry with just a flick. You can optionally add two screws if you're worried that the panel will pop out when you're not looking. Under ordinary circumstances, however, it's not possible to get in without pushing down on this widget. Unfortunately, it's a bit tricky to get the side panel back on, so this might not be the best case for first-time gearheads. The sound-absorption layer adds weight, so you need to grip the panel firmly on removal, to avoid gouging your desk.

2 HARD CASE

THIS CASE actually comes with three drive cages with a total of 10 drive trays. All cages are removable, even the 5.25-inch cage at the top. We kept only the smaller 3.5-inch drive cage and lifted it to a higher mounting point to make room for the videocard's radiator down below. We could have tossed all the drive cages, because there are two 2.5-inch mounts behind the motherboard, but then there would be nowhere to install the WD drive.

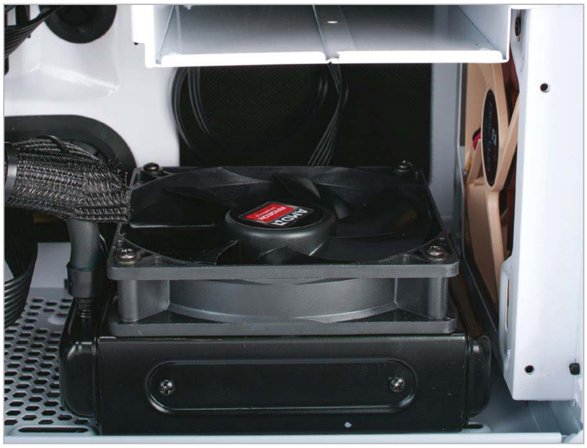
The case comes with silicone grommets that you can slide into a drive tray to absorb the vibration of a mechanical drive, and each tray can take a 2.5-inch drive as well. All of the trays are metal (which is rare), so you don't have to worry about snapping bits off through rough handling or dropping on the floor. And because this case is so wide, you don't need right-angle cables in the back.



3

SCREAMING FANS

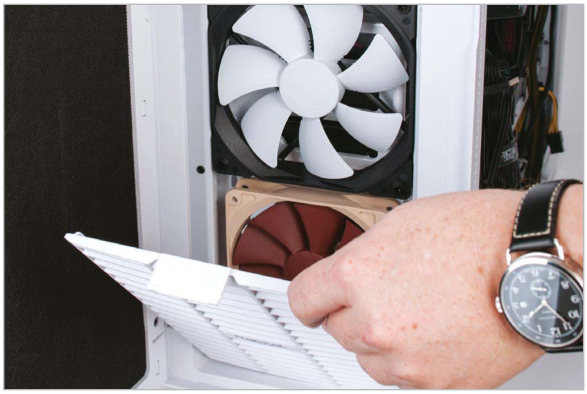
WITH THE DRIVE CAGE elevated several inches, we have enough clearance to install the videocard's radiator. The rad gets screwed in from below, after sliding out the dust filter underneath the case to make way for installation. We had some concern that the air coming from the case's front intake fan would get sucked into the rad's fan, which would mean less airflow across the motherboard, so we added a 120mm Noctua fan in front to provide more cooling. We also could have removed the ModuVent on the side to install a case fan there, but that would increase the noise level.



4

ACCESS ALL AREAS

THE LARGER FAN in the top of this image is 140mm and comes pre-installed. You can lift the dust filter away to access the whole front area. There are notches on the right of the fan mounts to feed their cables back into the case. At that point, you can connect them to the case's integrated three-speed fan controller, or plug them into mobo fan headers, if available. We opted for the controller. It gets juice from your power supply via a SATA power connector. You may have noticed there are no grills on the front. Instead, the R5 has vents on the sides to pull in air. This way, it can dedicate the front to a slab of noise-absorbing material. It's pretty slick. If you don't care about that, you can remove the door. It's just attached with a couple of screws.



5

WIDE LOAD

FROM ABOVE, you can see just how wide this case is. Those black screws are attached to a standard 240mm radiator (that of the H100i GTX that's cooling our CPU). Why would you want to shift everything to one side? That way, you don't have to worry about large mobo heatsinks or tall RAM sticks blocking the installation of a radiator and its fans. There's plenty of room to now add a second set of fans to the rad, which is pretty rare for a mid-tower. And there's room for a 360mm rad if you remove the 5.25-inch drive cage.

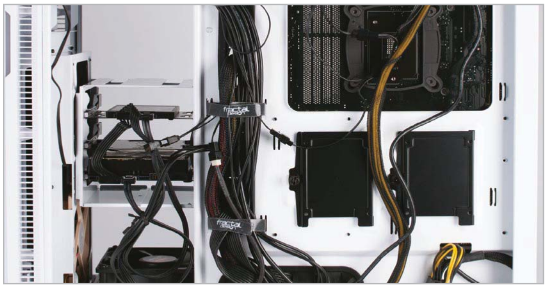
We installed the fans below the rad, pushing its heat out of the case. This is much easier than trying to sandwich the fans between the rad and the top of the case in a "pull" formation. Some cases have extra-wide mounting holes designed for case fan screws, but Fractal Design seems to understand that this location is more likely to be used for installing a radiator, so we had no issues there.

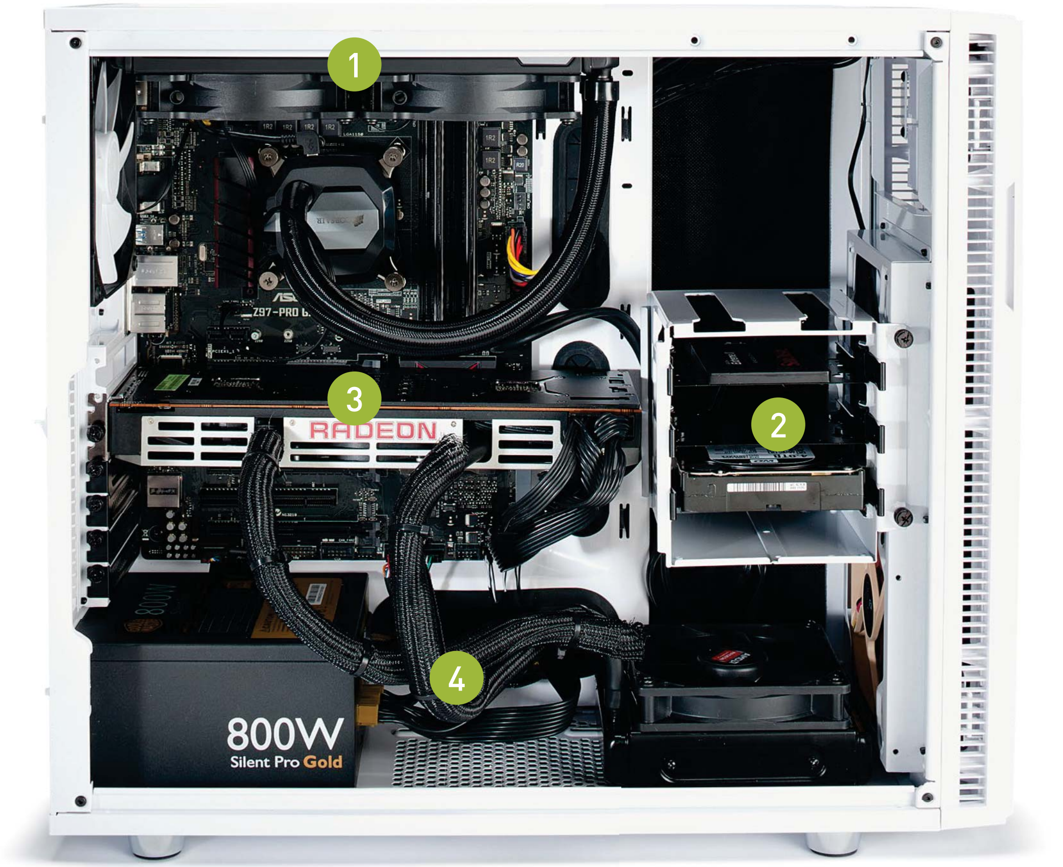
6

NICE AND TIDY

WE COULD TAKE CREDIT for the cleanliness, but it turns out Fractal pre-routed the cables coming in from the front (things like two USB 2.0 ports, two USB 3.0 ports, headphones, and mic) and strapped them down with these Velcro straps. We just had to take their lead, loosening the straps to make room for a 24-pin power cable.

The mobo tray is sunken compared to the R4, so there's less play behind it. That gives you the radiator clearance we talked about, and also allows taller air coolers. We can still send a rounded 8-pin CPU cable back here without contortions. You'll note a similar-looking cable down below. This is for PCIe power. It's integrated into the power supply, so we can't remove it. We went with two modular cables because they were flat (and so more flexible) plus all-black (making them less noticeable). We hooked up the fan controller and two drives with a single SATA cable.





1 The top of the case can take a 280mm radiator, but only if it's mounted toward the front, since the screw holes are too close to the rear.

2 We put grommets in the drive tray that we didn't use, in case we wanted to add a hard drive later and couldn't find the little bag that holds these widgets.

3 Despite this videocard being about 12 inches long, there's still plenty of clearance between it and the drive cage.

4 We used this 295X2 in the Dream Machine last year, which is why it has the sleeved tubing. The "stock" version has bare tubes.

ROCKET RIG

OVERALL, this system felt like a solid gaming machine. We got an average of 145 frames per second in *Batman: Arkham City*, with all settings cranked up at 2560x1600 (other than Nvidia's proprietary PhysX). When running the videocard benchmarks, the 295X2's radiator pumped out a lot of heat through the bottom of the case, as expected, but the lower intake fan on the front of the case recirculated a minimal amount of that, thankfully. The best orientation for the rad would probably be on the top of the case or the side, if possible, since heat rises. But the bottom mount seems to do well in a pinch. And our 800-watt power supply had no trouble dealing with the hefty power requirements of this videocard.

Corsair's H100i GTX performed admirably, its fans hardly spinning up no matter what load we put on the CPU, which was overclocked from 4GHz to 4.4GHz and didn't go past 73 degrees Celsius. We probably could have pushed it to 4.5GHz, but we prefer being confident about the stability of the system versus cranking it up as hard as we can and quickly running a test before the thing locks up. That can be fun, but it's not representative. And with this radiator, the chamber on the side that connects to the tubes was a little wider than we anticipated, and the case's rear exhaust fan obstructed it. That's why the tubes are coming out on the "far" end, with the pump logo upside-down.

A fresh system is also super-snappy, allowing a full reboot cycle in less than 20 seconds. So you can get into the BIOS, make a tweak, and be back to Windows in a flash. The motherboard initially wouldn't let us boot at all, because we didn't have anything plugged into the CPU fan header (the cooler's fans plug directly into the pump). We had to hunt around before we found the setting to ignore that header altogether, but it's an important safety measure to have. By default, a system will shut down if the CPU gets too hot, but you can override that—at which point you better have everything plugged in correctly.

Despite its rocket-fueled performance, this system is a bit slower than our zero point in some tests, even with its higher clock speed. That's because the i7-3930K has two additional cores—and an MSRP of about $580. At about $340, the 4790K is not bad value.

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	2,327 (-16.4%)
Stitch.Efx 2.0 (sec)	831	766 (8.5%)
ProShow Producer 5.0 (sec)	1,446	1,270 (13.9%)
x264 HD 5.0 (fps)	21.1	19 (-11%)
Batman: Arkham City (fps)	76	145 (91%)
3DMark 11 Extreme	5,847	7,883 (34.8%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% 110%

Our current zero-point consists of a hexa-core 3.2GHz Core i7-3930K (turbo 3.8GHz), 16GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

Future

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TESTED. REVIEWED. VERDICTIZED.

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ORIGIN PC GENESIS PAGE 74

The black-and-red aesthetic gives the Genesis that HAL 9000 vibe.

ORIGIN
X99 SERIES
DDR4 8-DIMM
CORSAIR
AX1500i

Origin PC Genesis

Aggressive in more ways than one

YOU ALREADY KNOW that Nvidia's Titan X is Kick Ass, but do you know what's even more awesome? Three of them in SLI. With that philosophy in mind, Origin PC sent us its new Genesis rig to review. The box has three of those bad boys, all water-cooled, coupled with a 5960X CPU and 16GB of 2,666MHz DDR4 RAM, all wrapped up in the company's own bold full-tower chassis. It's a beautiful PC, and hands down the fastest we've ever tested.

Externally, the chassis looks as striking as ever. Ours came in an all-black finish, but there are different colors available. You also have some fancy lighting options, both on the inside and outside of the case, which you can control via an included wireless remote. While the frame of the chassis is mostly metal, we're not too fond of the external casing, which is primarily composed of plastic; it feels a little fragile. Both doors also come off completely, but don't re-attach as easily as they should; we often found ourselves having to push them back on snugly before we could securely lock them into place. Like the Cooler Master stacker chassis before it, this case also has an expandable bay on the bottom. In our case (no pun intended), the bottom bay houses most of the chassis fans.

Speaking of cooling, the beautiful-looking water setup comes by way of EK, which water-cools both the CPU and GPUs. In terms of performance, Origin PC's box flew. In anticipation of some of the monster rigs to come, we've updated our desktop zero-point PC to have three GTX 980s and a 5960X CPU, but this Origin rig completely blew it out of the water. Three 980s is a plenty fast setup, but in our newly updated suite of graphics benchmarks, three Titan Xs smokes it by 20 to 60 percent.

A FEW HICCUPS

It's worth noting, however, that we didn't see these graphical performance gains straight away. As a matter of fact, in both the *Batman* and *Tomb Raider* tests, Origin's system actually performed worse than our ZP. We tried playing around with and redownloading drivers, but nothing worked. After scratching our heads for a few days and working with Origin to resolve the issue, we discovered the Asus X99-Deluxe mobo had its PCIe configuration set to auto, and wasn't scaling up to Gen 3 mode. When we manually switched it over in the BIOS, our issues went away. Origin says it's working with Asus to solve this issue and luckily it's not hard to fix.

The CPU performance ended up being really impressive, besting our own closed-loop water-cooled 5960X by 13 to 24 percent in our benchmarks. That's a huge difference when you consider that both systems are running the same CPU. You can attribute that to Origin's aggressive overclocking. Unfortunately, however, it appears Origin might have gone overboard with its overclock by bumping its proc to 4.5GHz, as we encountered a CLOCK_WATCHDOG_TIMEOUT blue screen twice while running our multithread-heavy X264 benchmark. Origin agreed with us that it might be a result of the aggressive overclock, and said it's willing to help customers downclock their CPUs through multiple means of customer support if necessary. This problem, while annoying, has a pretty easy fix.

Back to the awesome stuff: We just used the Origin PC Genesis to play a bunch of the latest games maxed-out on Dell's super-intensive 5K monitor, and they looked awesome. (As a side note: A 5K monitor is actually 70 percent more intensive to run than a 4K monitor.) Average frame rates were 60 and above across the board, which is no easy feat. In fact, that's been impossible until now.

As you can see, the box is not perfect, and our various issues with it hold us back from giving the Genesis our Kick Ass seal of approval. Fortunately, these issues can be solved with a few simple tweaks, in under five minutes. If you can stomach what might be isolated incidents, you'll be left with one beautiful and bad-ass PC. –**JIMMY THANG**

VERDICT 9

Origin PC Genesis

+ **SEGA GENESIS** Beautiful; smoking fast; gorgeous internals; external fan controller.

− **SEGA SATURN** Overclock is too aggressive; PCIe configuration issues; plastic doors.

$9,278, www.originpc.com

BENCHMARKS

	ZERO-POINT		
Stitch.Efx 2.0 (sec)	806	649	(24.1%)
Proshow Producer 5 (sec)	1,472	1,152	(21.7%)
X264	33.8	38.3	(13.3%)
3DMark Fire Strike Ultra	8,016	11,572	(44.3%)
Batman: Arkham City (GOTY)	204	246	(20.5%)
Tomb Raider (4K)	87.5	143.9	(64.4%)
Shadow of Mordor (4K)	70.1	110.7	(57.9%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a 5960X CPU, three GTX 980s, and 16GB of RAM. *Arkham City* tested at 2560x1440 max settings with PhysX off. *Tomb Raider* at Ultimate settings. *Shadow of Mordor* at Max settings.

SPECIFICATIONS

Processor	Core i7-5960X 4.5GHz
Mobo	Asus X99-Deluxe
RAM	16GB DDR4/2,666MHz
Graphics	3x GeForce GTX Titan X in SLI
Storage	1TB Samsung 850 Evo Series SSD/4TB Seagate SSHD
Optical	16X Blu-ray Burner
Case/PSU	Case/PSU

Silverstone Tundra TD02-E

This cooling ain't fooling around

LAST YEAR, we reviewed Silverstone's original TD02 closed-loop CPU cooler (CLC). It used a 240mm radiator, which had integrated tubing that fed heat coming from a pump and heatsink combo that sits on top of the CPU. Enthusiasts like CLCs because they can allow higher CPU overclocking than a conventional air cooler. They also take some weight off the mobo, though modern backplate designs tend to make that a non-issue. But the TD02 wasn't perfect. Its radiator was thick, so it couldn't fit in some cases. The tubes were also a bit undersized, so it could have trouble getting heat to the rad.

We liked the aluminum pump housing of the original, and the white tubing and fan blades. But we were apparently in the minority. When you unbox the TD02-E, you'll see black rubber tubing and fan blades, and no white accents on the rad. Silverstone's literally gone to the dark side, though there's a shell with a carbon fiber-style pattern on it. Plus the firm's snowflake logo is still present, glowing blue on top of the pump.

The radiator is 27mm thick instead of the usual 25mm, but that's unlikely to be a problem. It still uses a dense soldered fin array, which creates better contact than non-soldered fins, and the higher density increases the cooler's effective surface area. You need proportionally stronger fans to compensate for the thicker array, but that's definitely not a problem for Silverstone, a company known for designing its own fans for a variety of roles. The TD02-E fans' blades are highly angled for better penetration, whereas regular case fans will have flatter blades, because they don't need to focus their airflow.

FEELING THE HEAT

Anyone who's installed a CLC before will find no surprises. Silverstone uses a metal backplate, which is a nice touch and adds to the cooler's durability. Users of LGA 2011 mobos have a set of mounting screws, and the cooler drops right in and is secured by four metal fasteners. You can get it all in with a Phillips screwdriver. Silverstone also includes an adapter to connect both fans to one fan header, which seems a no-brainer but sometimes isn't provided.

The TD02-E operates quietly, yet it idles this hex-core Intel Core i7-3960X just 10 C above room temperature. When

we put the nightmare-level load on this chip, the heat rises up to 71.6 C, which is higher than we'd like. But the cooler stays nice and quiet despite the CPU being overclocked to about 4.2GHz at this point. Once that test was done, we instructed the "AI Suite" software of our Asus Rampage IV Extreme motherboard to set the fans to "Turbo" mode. Temps dipped to 70 C. Still a few degrees higher than we'd like, but respectable when you consider how much heat the CPU is generating.

Unfortunately, the CLC market is packed with some competitive entries from the likes of Cooler Master and Corsair, who will get your chip cooler for about the same price and with the same noise level. And of course, if your case can fit a 280mm radiator instead, this Silverstone unit pales in comparison. So we can't crown the TD02-E as the new king. In fact, our tests indicated the original performed a bit better, probably thanks to its thicker rad. But if the TD02-E can keep a hex-core CPU at 72 C when clocked to 4.2GHz, it should be more than enough for a chip that uses the smaller LGA 1150/1155 socket.

–TOM MCNAMARA

VERDICT 8

Silverstone Tundra TD02-E

⊞ **COMMODORE 64** Solid cooling and acoustics; improved dimensions on original TD02.

⊟ **ATARI JAGUAR** Could perform better for the money.

$100, www.silvertstonetek.com

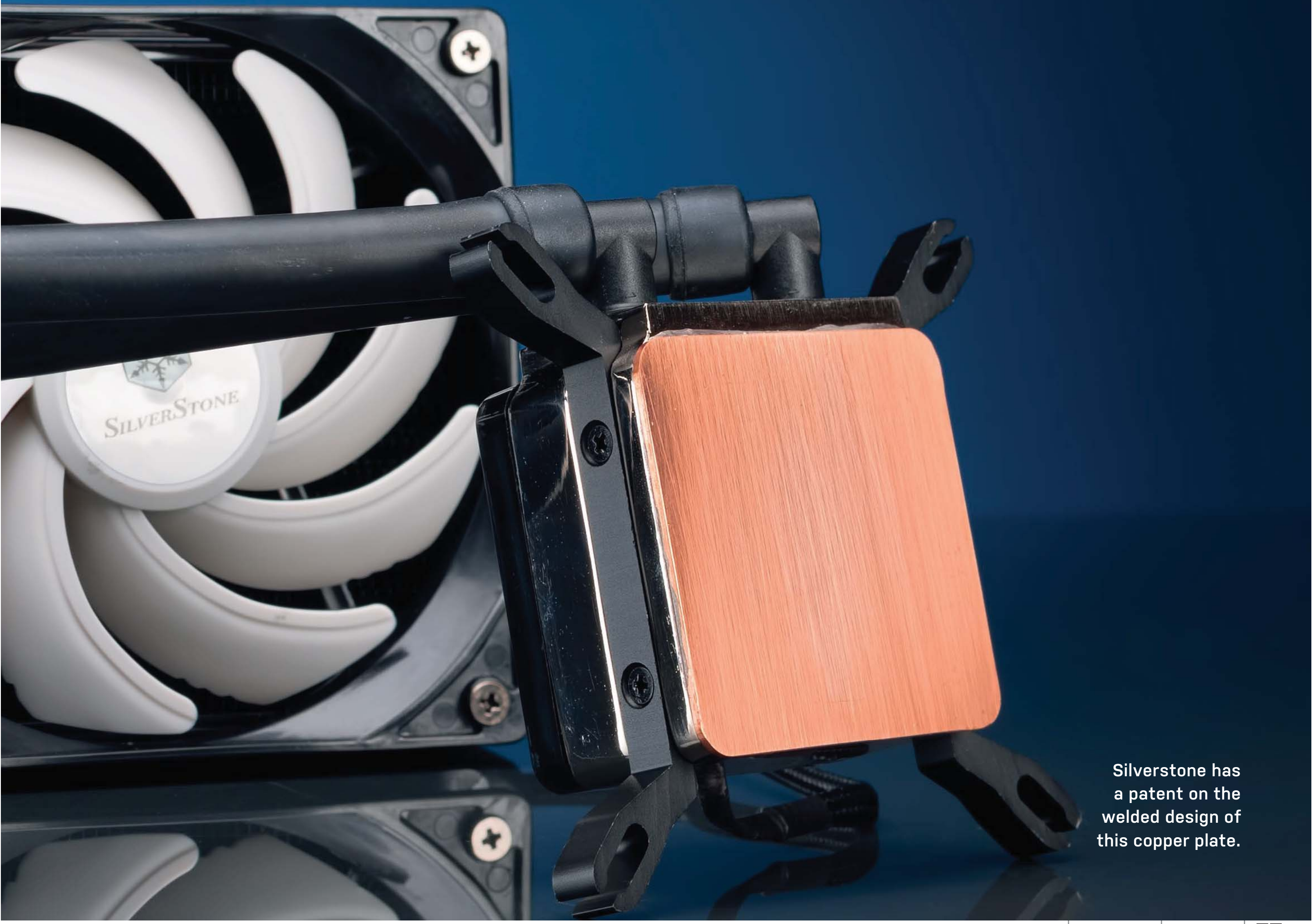
BENCHMARKS

	Tundra TD02-E	Cooler Master Nepton 280L	Tundra TD02	Corsair H100i
Ambient Air	23.4/23.4	22.1/22.4	**19.8/19.8**	20.3/20.5
Idle Temperature	33.1/33	33.2/30	**29.8/29.5**	30.7/29.3
Load Temperature	71.6/70	**64.5/63.3**	65.8/63.0	67.1/61
Load: Ambient	48.2/46.6	**42.4/40.9**	46.0/43.2	46.8/40.5
Street Price	$100	$120	Discontinued	$100

Best scores are bolded. First number is Quiet mode, second is Performance. All temperatures in degrees Celsius. All tests performed with an Intel Core i7-3960X at 4.2GHz, on an Asus Rampage IV Extreme motherboard in a Corsair 900D with stock fans set to Standard.

SPECIFICATIONS

Radiator Dimensions (H x D x W)	11 x 2.1 x 4.9 inches
Stock Fans	2x 12cm PWM
Socket Support	LGA775/1150/1155/ 1156/1366/2011/2011-3 AM2/ AM2+/AM3/ AM3+/ FM1/FM2
Additional Fan Support	2x 12cm



Silverstone has a patent on the welded design of this copper plate.

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Netgear Nighthawk X6

Freaky looking, but can it banish the dead spots in your home?

THE FIRST THING you'll see is the price. It's certainly not budget. And then there's those antennae. There's so much tech inside this box that it wouldn't be that much of a leap for it to flip itself over and start scuttling off like a robot crab.

There's a 1GHz dual-core processor on board, plus 128MB of flash memory and 256MB of RAM, with three offload processors powering three separate Wi-Fi networks—one for legacy 2.4GHz devices (up to 600Mb/s theoretical) and two separate 5GHz networks (cited as a massive 1,300Mb/s). Now, that's a router. It won't surprise you to learn those speeds are theoretical lab speeds. The fastest we got over the 5GHz network was around 350Mb/s. Still pretty fast.

The three networks essentially enable you to spread out the bandwidth demand of the devices in your home—if they're too old, they can be sidelined on the legacy network. If they're 5GHz capable but not that important, you can stick them on the second network (your sister's iPad, your dad's PC). And then the second 5GHz network is where you come in—an oasis of bandwidth for your performance PC.

Surprisingly for such a supercharged device, it doesn't run like some other networking kit that makes you think you've actually bought a heater. And setup is really very simple thanks to a comprehensive Quick Start guide and browser-based configuration interface. Build quality is great except for those antennae, which feel like they could snap off at any moment (but in fairness, you won't touch them much).

There are two USB ports in the back, one USB 2.0 and one 3.0. They can be used to share devices across your network, creating instant network storage. You can also use one of the ports with the ReadySHARE Vault backup app—this PC software automatically backs up your system to a connected drive.

SWITCH HAPPY

You also get the bombastically named Beamforming+ tech. This isn't a proprietary Netgear technology, but actually part of the 802.11ac Wi-Fi standard. And it's impressive. The router can assess the location of the client PC or device and sends focused (directional) signals to that device. Clever stuff. The result is a more stable connection and networking gear that's finally able to do something about dead spots. We found the client laptop we used as our roaming benchmark device achieved better coverage in the next-door room than in the same room as the router.

Netgear has come a long way since it had to retrospectively provide a "hat" to nullify the room-brightening effect of its RangeMax router—the Nighthawk X6 has a slide switch on the back to turn the raft of LEDs on and off (though the power one always stays lit). It's a provision that's necessary for those who have the router in the same room that they sleep in.

There are almost too many LEDs here, with one for each wired port, the two USB ports, the three wireless networks, power, Internet connectivity, WPS, and Wi-Fi on/off. That's 13 in total. The latter two LEDs are actually switches—it's really useful to be able to flick Wi-Fi off, if you're away over a weekend, for example. There's also a full on/off switch on the rear.

As our tests show, download speeds proved quite resilient at distance and we don't see the Nighthawk X6 encountering any issues in providing total Wi-Fi coverage across your home. But the real boon of the X6 is its ability to cope supremely with multiple devices. We had no issues there whatsoever. And you might feel that's worth the price tag alone. **–DAN GRABHAM**

VERDICT

8

Netgear Nighthawk X6

+ **BB-8** Supreme choice for multiple-device homes; impressive range and throughput.

− **JAR JAR** Heavy premium to pay for network supremacy.

$277, www.netgear.com

BENCHMARKS

	Max Mb/s	1.19TB file transfer (secs)	Mb/s of copy procedure
Upstairs, back of the house	348.1	116	84
Next door room	172.8	198	49.2
Downstairs, front of the house	157.2	192	50.8
Rear of garden (15m from router)	34.4	313	31.1
Road at rear (25m from router)	11.1	446	21.9

We carried out two tests in a "dirty" household environment, with two phones, a tablet, a TV, a set-top box, and three computers connected to our network (though not actively downloading anything). We then measured the throughput of the router outright, before performing a copy procedure of a 1.19TB file across one of the Netgear's 5GHz wireless networks between two PCs. We did both of these tests in several locations, inside and outside.

SPECIFICATIONS

Wi-Fi	802.11ac Tri-Band Gigabit
USB	1x USB 2.0, 1x USB 3.0
Wireless Networks	3x3 (2.4GHz) + 3x3 (5GHz) + 3x3 (5GHz)
Ethernet	10/100/1000 (1 WAN and 4 LAN) Gigabit Ethernet ports
Memory	128MB Flash, 256MB RAM
Processor	1GHz dual-core processor with three offload processors
Warranty	One-year limited
Dimensions	295.5 x 226.8 x 54.5mm

intel
inside™

A full-fledged PC in an ultra-small package.

Intel Compute Stick STK1A32WFC

An impressive first step for ultra-small PCs

WHEN INTEL ANNOUNCED the Compute Stick, at January's Consumer Electronics Show (CES), in Las Vegas, we were pretty excited. Sure, there's a handful of devices already on the market that get content onto your TV—Amazon's Fire Stick and Google's Chromecast are both competent devices, for example, while there are also more powerful options available, such as the Roku. But Intel's Compute Stick is a full-fledged x86 Windows 8.1 PC. And that makes a big difference.

On the outside, the Compute Stick is minimalistic in design. It's slender and black and has slits for intake and a small fan that exhausts hot air. The fan isn't loud by any measure, but does emit a high-pitched whine. On one side of the Compute Stick is a micro-USB port for charging, and a regular USB 2.0 port for accessories like a keyboard and mouse. The opposite side has a MicroSD slot, if you feel 32GB is too claustrophobic. For light computing duties, we didn't feel the need to upgrade.

Plug the Compute Stick into a TV's HDMI input, or a normal desktop display, and you're good to go. We opted for a 24-inch Dell LCD panel. Internet connectivity is handled by 802.11bgn. Unfortunately, no 802.11ac support is integrated, and the onboard Wi-Fi is only single-channel 2.5GHz, with no 5GHz support.

On booting, we went through the normal Windows 8.1 setup. Once that was over, we landed on the desktop. It felt like a normal PC, which is awesome in light of how small the Compute Stick is. After all the Windows updates were installed, we loaded our usual array of apps and installed Steam. Once Steam was installed, the Compute Stick became another beast entirely.

MIXED RESULTS

Valve enabled Steam In-Home Streaming a while ago, and we realized that the Compute Stick would be a pretty great solution. And it was. We tested *Ori and the Blind Forest*, *Grand Theft Auto V*, and *Dota 2*. All games played without fail through Steam In-Home Streaming, and felt like we were playing on an actual desktop. We then attempted to play games natively on the Compute Stick, but that was a futile exercise. Even Valve's original *Portal* was a miserable experience, with all settings turned to low or off. Streaming is where the Compute Stick really excels, and we're happy to let it do just that.

Aside from streaming, performance on the Compute Stick was relatively good. However, with four or more casual applications open, you start to feel the effect of having only 2GB of RAM and limited CPU power. Chrome tab refreshes start to noticeably lag. General computing performance is on par with a netbook.

We ran some basic benchmarks on the Compute Stick, since it can't really handle our usual array of desktop-class tests. For reference, we included numbers from an Intel Core i7-4960X desktop with 8GB of RAM (thus showcasing a David versus Goliath scenario).

The Compute Stick just isn't meant for heavy-duty PC chores or native gaming. It's meant for casual work or content consumption and entertainment. For all intents and purposes though, that's fine. Gamers who are looking for a lightweight streaming solution should give the Compute Stick a serious look.

There's a lot of promise in this platform. Consider this iteration a step in the right direction, pointing to a bright future for small computing machines. There will be a day when a device such as this will be able to hold its own as a full-fledged HTPC. For the *Maximum PC* reader looking for a powerful solution, though, today is not that day. **–TUAN NGUYEN**

BENCHMARKS

	Intel Compute Stick	4960X Desktop
GeekBench 3.3.2 32-bit Single-core	781	**2,195**
GeekBench 3.3.2 32-bit Multi-core	2,195	**20,891**

Best scores are bolded.

VERDICT
7

Intel Compute Stick STK1A32WFC

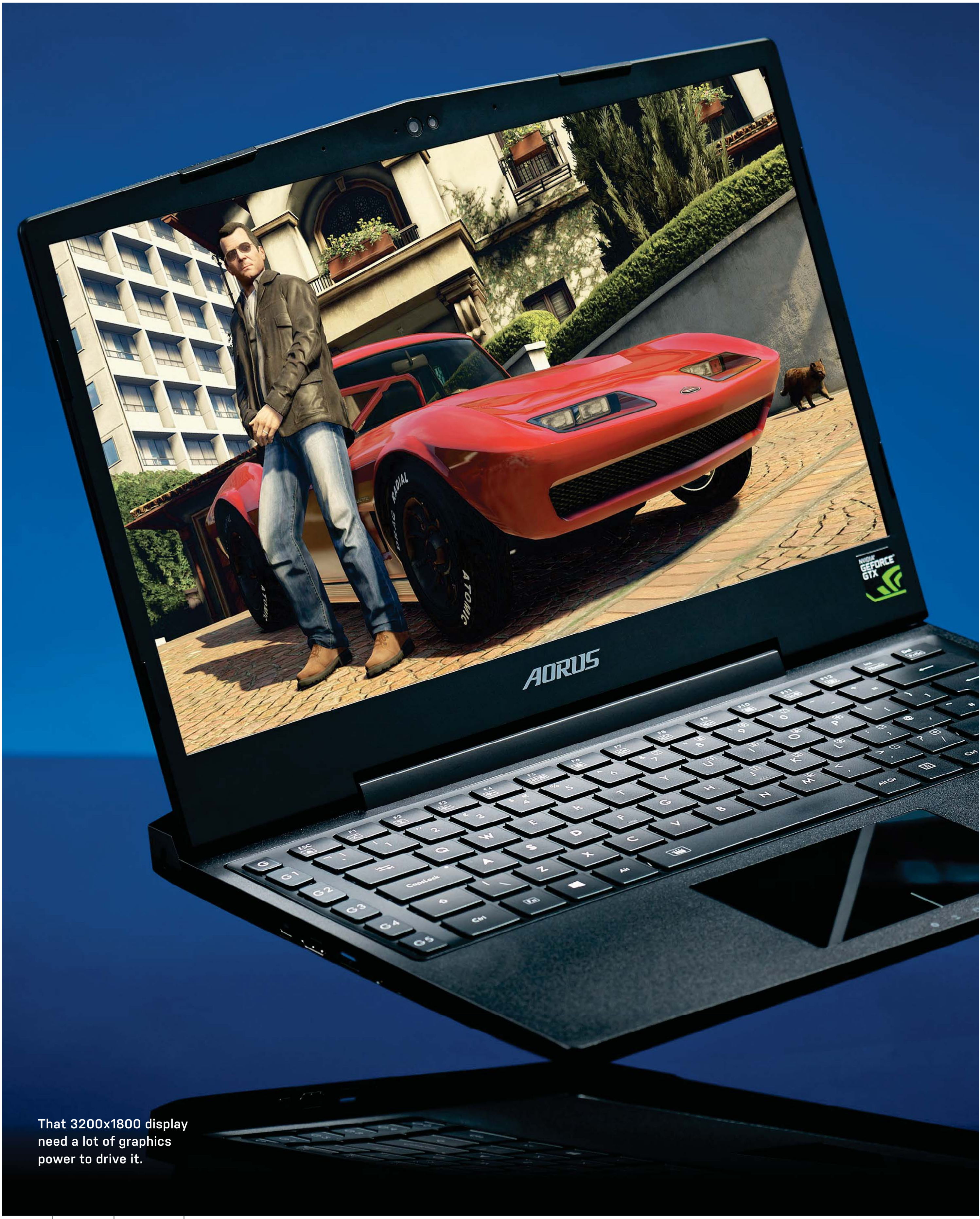
+ **RHYTHM STICK** It's a full-fledged Windows 8.1 PC; ultra-small; does Steam In-Home Streaming well.

− **STICK BUG** 2GB of RAM hurts performance; smartphone CPUs are more powerful; Windows 8.1 adds overhead.

$150, www.intel.com

SPECIFICATIONS

CPU	Intel Atom Z3735F
Graphics	Intel HD Graphics
RAM	2GB DDR3L 1,333MHz
Storage	32GB eMMC
Connectivity	802.11bgn, Bluetooth 4.0, MicroSD
Size (H x W x D)	4 x 1.5 x 0.5 inches


AORUS
NVIDIA GEFORCE GTX

That 3200x1800 display need a lot of graphics power to drive it.

Aorus X3 Plus V3

More of some, less of another

MORE IS ALWAYS BETTER, RIGHT? The X3 Plus V3 is all about more. More pixels (5.76 million), more VRAM (6GB), more heat, and more fan noise. There's a bit less of one thing though, the three SSDs we'd assumed the X3 series was named after have been pruned back to two: 256GB mSATA models in a RAID 0 (striped) configuration.

Aorus, owned by Gigabyte, has designed a slab of black aluminum with vents on the back that make it look like a stealthy Cobra Mk III from *Elite: Dangerous*. The keyboard is backlit to look like a birthday cake, but without much in the way of key travel, and marred by a crunchy F8 key. Plus the slippery puddle it calls a trackpad hides an unresponsiveness beneath its good looks.

The power button is on the side, marked only by a symbol etched into the case. This means there's no extra button on top to blight its fearful symmetry. The case is slim, but it's a heavy beast, close to gaming machines from Razer and Alienware.

As for the screen, the ridiculous number of pixels sit high on the lid with a large black bar underneath them. This has the odd effect of making it feel as if you're using a screen taller than a 16:9 ratio usually is. We're sure there are reasons for using a 3200x1800 display, rather than splashing out on a UHD-1 screen, but going over 1080p on a 14-inch gaming laptop seems a step in the wrong direction. Current mobile GPUs just aren't up to pushing that many pixels at any sort of reasonable rate.

HOT STUFF

Dropping down to 1080p will double your frame rate and, happily, the screen will display this resolution beautifully. Windows 8.1's high-res screen support means the interface doesn't become tiny when you're doing something other than gaming. Just occasionally, the Steam window became so small it was impossible to read, but restarting the app fixed it. Feed the X3 a 4K movie, however, and it's in its element.

The back vents are for cooling. Trying to run *Metro: Last Light* at the screen's native res sends the fans spinning into a rage and leads to the keyboard and base becoming uncomfortably hot. You'll definitely want to use this on a table. Front openings on the sides are speakers, but don't go expecting much. A decent headset is a necessity.

With three USB3 ports, a card reader, HDMI, 4K-friendly Mini DisplayPort, and Ethernet, the X3 is well-equipped. It runs Lightroom like the wind, and the high-res screen makes photos look great, but a lack of storage means an external drive is needed for anyone editing on the run.

The X3's blisteringly fast RAID storage stands out, but the rest of the package is a solid mix of components that, if you can stand the heat, will do justice to today's demanding games. **–IAN EVENDEN**

VERDICT
8

Aorus X3 Plus V3

+ SPEED High-speed; high-res; high-quality.

− BLEED High-temperature; high-volume; high-cost.

$2,200, www.aorus.com

SPECIFICATIONS

CPU	Intel Core i7-4710HQ 2.5GHz
GPU	GTX 970M (6GB GDDR5)
RAM	16GB DDR3L-1866
Screen	13.9-inch, 3200x1800
Chipset	Mobile Intel HM87 Express
Storage	512GB SSD (2x 256 in RAID 0)

BENCHMARKS

	Aorus X3 Plus V3	Schenker XMG P505	Asus G751JY
Cinebench	654	**676**	674
Heaven (min/avg fps)	5/15	17/54	**27/56**
BioShock Infinite (min/avg fps)	8/73	8/80	**15/95**
Metro: Last Light (min/avg fps)	9/13	13/39	**23/42**
Shadow of Mordor (min/avg fps)	21/28	**43/66**	34/69

Best scores are bolded. All the 3D tests were carried out at their max settings with 4x antialiasing and at the laptop's native resolution.

Intel SSD 750 1.2TB

Is this the second coming for SSDs?

WIPE THE SLATE CLEAN. Forget the SATA interface and forget the AHCI protocol. This is high bandwidth NAND Flash-specific storage of the highest order. This is solid state all grown up and forging its own path.

Since the first consumer SSDs hit our PCs, they've been piggy-backing high-latency mechanical drive tech in terms of their interfaces and protocols. In the beginning of the SSD revolution, running across the 600MB/s limit of the SATA 6Gb/s interface wasn't much of a problem. But quickly our SSDs became more trustworthy and more capable, and suddenly they were bumping their heads against the limits.

Along came PCIe-based drives, but they were mostly still smaller SATA drives connected to a PCIe RAID controller. Then came actual PCIe interfaces specifically designed for SSDs. The new wave of Flash storage had begun. The M.2 socket and the still mostly unused SATA Express arrived with the Z97 and X99 chipsets.

But breaking clear of the bandwidth limitations of the SATA interface is only one strand in unlocking the true potential of solid-state storage. The other is all about getting around the legacy setup. The AHCI protocol was introduced when SSDs were a mere twinkle in an old USB stick's eye, and has been almost inextricably linked to high latency spinning platters.

That setup still works fine for mechanical drives, but the legacy commands in AHCI still have to be run through, even when an SSD is in place. The drive then has to go through each legacy command, even if they have no relevance to high-speed SSDs. That wastes an awful lot of CPU cycles.

When Intel introduced its enterprise level DC P3700 NVMe drives, it used the Linux AHCI stack as an example of the wasted time and power that goes into running an SSD across the legacy protocol. Using a quad-core i5, the Linux stack runs to 27,000 CPU cycles, meaning it needs a full 10 Sandy Bridge-level cores to drive one million IOPS (input/ouput operations per second). With the streamlined NVMe Linux stack, that's cut by around a third, needing only 10,000 CPU cycles to reach the magic million figure.

THE GIGABYTE/S ERA

That enterprise drive is important, not just for providing an example of how powerful the NVMe protocol can be. It also forms the basis of this first consumer NVMe drive. The bespoke controller at the heart of the P3700 is the same 18-channel controller as the one that makes the SSD 750 so speedy. That controller is kept honest with a hefty 2GB of DDR3 cache on this 1.2TB version.

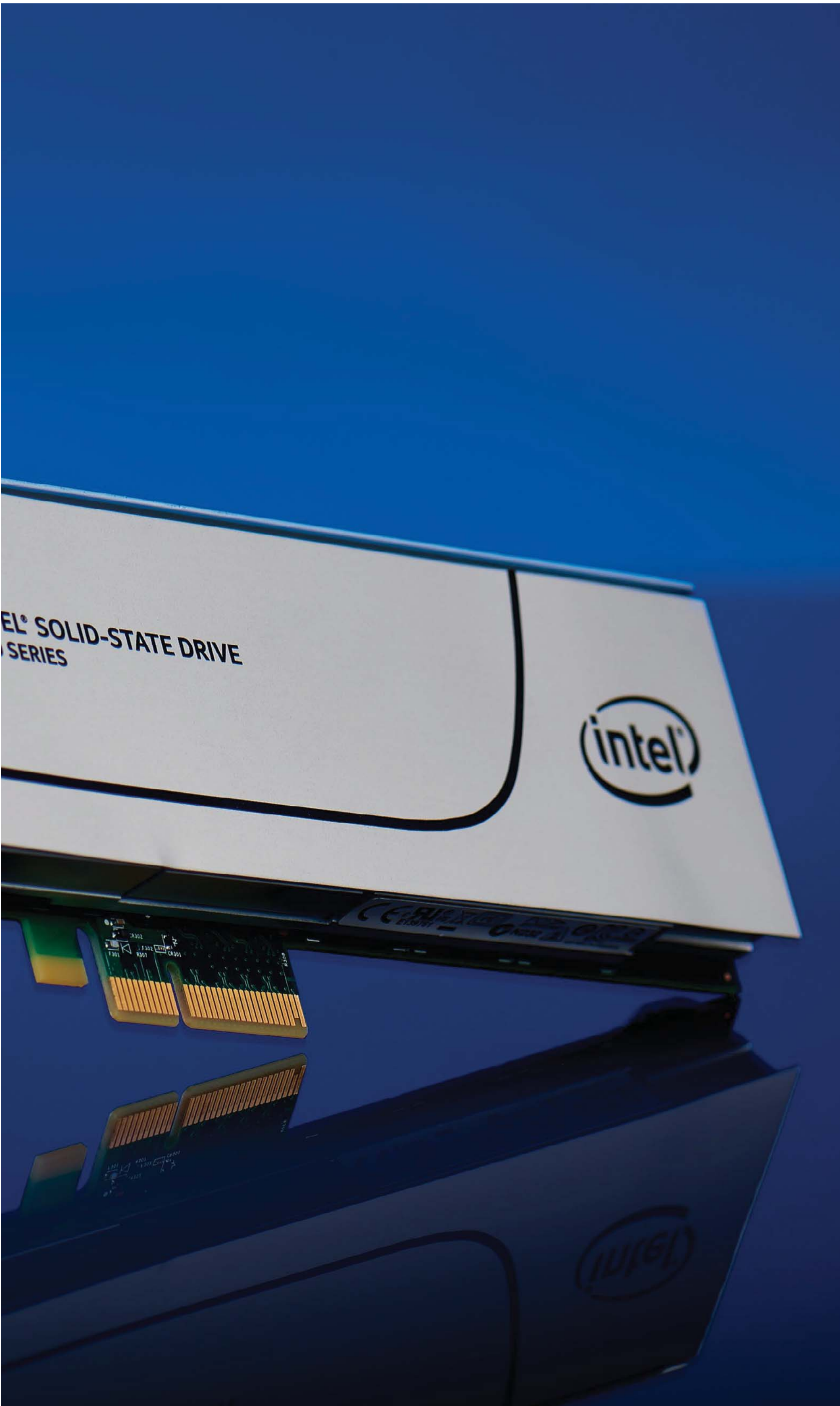
Its top speed? The peak sequential numbers from ATTO are unprecedented. The reads were almost 2.7GB/s and the writes were 1.3GB/s. The scores on the harder AS SSD benchmark were lower, but 2.1GB/s and 1.2GB/s respectively isn't bad. We're shifting from talking in MB/s here...

There are some interesting scores when we get to the 4K random read/write performance. At 38MB/s, the 4K random read speed isn't amazing, but the write performance of 200MB/s is stunning, nearly twice as quick as the closest competing drive. Compare all that with the fastest PCIe drive we've previously tested, the Samsung XP941, and you can see where the AHCI protocol is holding things back. Its 4K write performance is a quarter of what the SSD 750 can achieve.

BENCHMARKS

	Intel SSD 750 1.2TB	Samsung XP941 512GB	Samsung 850 Pro 512GB
ATTO Read/Write Speed (MB/s)	**2,671/1,322**	1,060/997	561/532
AS SSD Read/Write Speed (MB/s)	**2,136/1,175**	1,055/885	528/500
AS SSD 4K Read/Write Speed (MB/s)	**38/200**	23/49	37/107
5GB File Compression (seconds)	**69**	73	73
30GB Folder Transfer (seconds)	**120**	132	169
PCM8 Consistency (index)	**4,906**	4,849	4,751

Best scores are bolded. Our testing platform is a stock-clocked Intel Core i7-4770K on an Asus ROG Maximus VII Hero Z97 motherboard with 8GB Corsair Dominator DDR3 at 1,600MHz.



There we have it then. The 750 is the fastest SSD we've ever tested, and by a comfortable margin. But it's also one of the most expensive. The problem with being a brand new technology, and being first to market, is that it will always command a high price tag. That's especially true given there's still no NVMe competition. Couple that with the fact it's Intel, and prices were always going to be sky-high. This is like the Extreme Edition CPU of solid-state drives.

But there's a certain justification. Intel has had to invest heavily in the ecosystem of NVMe, working to ensure all mobo makers are able to get BIOS support for their Z97 and X99 boards. The SSD makers who will follow up with inevitably cheaper NVMe-based SSDs won't have that R&D cost.

There's a little bit of the Titan X about the SSD 750. It shares the basic core silicon with its pro-class brethren, the P3700, so it's got similar levels of performance. But the 1.6TB enterprise drive is well over $5,000, while this high-capacity, high performance drive is *just* $1,030. Looking at the cost per GB makes it look less extortionate. When Intel released the X-25M, the first real performance SSD (for all its subsequent faults), it cost $3.72 per GB. This 1.2TB drive delivers a far lower 86c/GB.

And prices will tumble. This is the birth of NVMe. The ecosystem is there now, so you can bet NVMe-based SSDs will be appearing from everyone by the end of the year. It'll go crazy once Marvell and SandForce's controllers are out there. June's Computex is likely to be built upon a sea of NVMe drives. Plus, we doubt this is as fast as an NVMe drive can go. The 750 sure looks lightning-fast, but we'll know more once competing NVMe controllers are out in the wild. For now though, this is as quick as it gets. **–DAVE JAMES**

If you can't fit another PCIe card into your SFF build, Intel is making a 400GB 2.5-inch version, too.

VERDICT

9

Intel SSD 750 1.2TB

+ FLASH Superb performance; simple to use; huge capacity.

− TOO MUCH CASH Extremely expensive; 2.5-inch version needs rare connections.

$1,030, www.intel.com

SPECIFICATIONS

Capacity	1.2TB
Memory	Intel 128Gb 20nm MLC NAND
Controller	Intel CH29AE41AB0 (18-channel)
Interface	PCIe 3.0 x4 - NVMe
Cache	2GB DDR3
Warranty	5 years

P/N: MZHPV256HDGL-00000
S/N: S1X2NYAG300307
Model: MZ-HPV2560
MSIP-REM-SEC-MZ-HPV2560
RATED: DC+3.3V 1.9A
WWN: 500253890000521B
1511
REV 0
F/W BXW2500Q
SM951
2015.03
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Product of KOREA
WARNING: Product can be damaged by Electrostatic Discharge (ESD).
www.samsung.com/ssd
WARRANTY VOID IF REMOVED

Staggering speeds from its PCIe 3.0 x4 interface.

Samsung SM951

Another blisteringly fast, but slightly easier-to-find, Samsung M.2 PCI Express SSD

A LITTLE WHILE BACK, we got our hands on Samsung's 512GB XP941 M.2 PCIe SSD—a rare creature in the wild, but one worth tracking down for its stunning performance. Well, stunning that is, if you could run it at its full x4 PCIe speed. But now we have our hands on its successor, the slightly easier-to-obtain SM951.

This M.2 drive first saw the light of day at Samsung's annual shindig, the SSD Global Summit, which took place, in South Korea, last July. When it was first announced, the company claimed it would be the world's first NVMe SSD for the PC, but that idea got kicked out of the window by the powers that be, as the drive only supports the good old AHCI architecture. (Samsung has just announced it's started mass production of the NVMe version of the drive, called the SM951-NVMe).

Like the XP941, the SM951 is handled by the Korean firm's OEM branch, which is why getting hold of one without buying a device with it pre-installed is a bit tricky. The drive comes in three capacities, the entry level 128GB, the 256GB drive (our review sample), and the flagship 512GB unit. There's no 1TB drive, as per the original announcement, and all are the M.2 2280 format (22mm wide, 80mm long).

The XP941 used a 3-core Samsung S4LN053X01 controller with a PCI Express 2.0 x4 interface. The SM941, meanwhile, uses a Samsung S4LN058A01 controller, again a 3-core chip, but with a PCI Express 3.0 x4 interface. So, what does moving from 2.0 to 3.0 PCIe do then? Well, in theory it doubles the bandwidth—you only have to look at the quoted sequential read/write performance figures of the drives to see the advantage of the 3.0 interface. The 256GB XP941 is quoted as up to 1,080MB/s and 800MB/s for read/writes respectively, while the 256MB SM951 surpasses that by some distance with figures of 2,150MB/s reads and 1,200MB/s writes. But while this drive has hugely fast sequential speeds, it remains way off the 3.2GB/s maximum bandwidth of the 3.0 x4 bus.

BOOTS 'N' ALL

Surprisingly, given what Samsung is doing with 3D-NAND, the SM951 uses old-fashioned 2D planer 10nm class MLC NAND. In all probability, the same 19nm 64Gb MLC NAND used in the XP941. Also added to the SM951 is support for the PCIe L1.2 power state, which can be looked at as the PCIe equivalent of DevSleep that's supported by some standard SSDs. Another advantage of the SM951 over the previous model is that it's bootable (with the right motherboard that is), so make sure you do your homework before buying either drive or motherboard.

To test the drive at its full x4 PCIe potential, we used an Asrock Z97 Extreme6, one of the few Z97 boards that can run these drives at full speed, thanks to its extra M.2 x4 port. Alternatively, there's Intel's X99 chipset, or you could use an adapter card, such as the Lycom DT-120.

It takes some believing, but even the quoted figures for the sequential reads seemed conservative when the SM951 was tested with the ATTO benchmark, the drive producing a score of 2,253MB/s. However, the write performance was bang on the money at 1,272MB/s. When it comes to handling the small 4K files of everyday use, the SM951 shows once again the advantage of the extra bandwidth available to it with a read speed of 44.59MB/s, in the AS SSD 4K test, compared to the XP941, but the biggest improvement comes in the write figures. The XP941 gave up a score of 73.05MB/s, totally eclipsed by the 132.31MB/s produced by the SM951.

These figures add up to make the SM951 an incredible SSD. In fact, the only thing holding us back is the promise of the imminent NVMe version. **–SIMON CRISP**

VERDICT 9

Samsung SM951

⊞ **LIGHT SPEED** The fastest M.2-based drive we've tested; certainly the fastest 256GB consumer drive around; bootable with the right mobo.

⊟ **STALLED** Still expensive for a 256GB drive (though it's only $40 more than its predecessor); tricky to find without buying it pre-installed; not an NVMe drive.

$260, www.samsung.com

BENCHMARKS

	Samsung SM951 256GB	Samsung XP941 512GB
ATTO Sequential Read (MB/s)	**2,253**	1,091
Sequential Write (MB/s)	**1,272**	1,003
AS SSD Sequential Read (MB/s)	**1,989**	1,144
Sequential Write (MB/s)	**1,184**	900
4K Read (MB/s)	**44.59**	29.65
4K Write (MB/s)	**132.31**	73.05

Best scores are bolded.

SPECIFICATIONS

Capacity	256GB
NAND Type	Samsung 19nm Toggle MLC
M.2 Format	2280
Quoted Sequential Read Speed	Up to 2,150MB/s
Quoted Sequential Write Speed	Up to 1,200MB/s

That shiny stand can't hide the fact there's no height adjustment.

Acer Predator XG270HU

Our first FreeSync monitor touches down, but can it give the pricey Asus Swift a run for its money?

ACER'S NEW XG270HU is the first monitor we've tested that offers AMD's frame-syncing technology, FreeSync. It's a high-end, high refresh rate panel that ought to deliver the best possible FreeSync experience at a fraction of the cost of something like Asus's range-topping Republic of Gamers Swift PG278Q screen.

In case you're wondering what FreeSync is, it's essentially a technology that leverages the Adaptive Sync part of the DisplayPort 1.2a protocol, to enable AMD graphics cards to speak to compatible monitors and display frames from the GPU when they're ready.

Nvidia's G-Sync and AMD's FreeSync are both designed to do the same thing, but the basic difference is that the green team requires the monitor manufacturers to license the G-Sync tech and install a specific hardware module in their displays, to sync with GeForce GPUs. AMD's tech is based on the newly established DisplayPort 1.2a Adaptive Sync protocols, and as such needs no new hardware, nor licenses. Because, y'know, it's free syncing.

Initially, we thought the Acer had grabbed the same AU Optronics panel the Asus Swift is using and, given that it's almost $300 cheaper, that would be a major feather in the cap for both Acer and AMD's FreeSync initiative. A quick specs check would seem to corroborate that initial thought—both are native 2560x1440 panels; they both use TN tech with a 1ms response time; and they both run with a 144Hz refresh rate. But there's one key spec that separates the two. The Swift is a true 8-bit screen while the Predator uses Frame Rate Control (FRC) to enhance its 6-bit monitor.

Putting the monitors cheek-by-jowl, you can see they're most definitely not the same. Aside from possibly a slightly improved viewing angle for the Acer panel, it loses out to the Swift in terms of image quality. Sometimes only by a touch, but sometimes by a wider margin. The contrast and gradients on the Acer are only slightly behind the expensive Asus monitor, but it's a long way behind when it comes to the black reproduction. It's also not so hot on the whites either, but both being TN panels, neither are exactly paragons in that regard.

STAND AND BE COUNTED

The addition of the G-Sync license and hardware isn't the only reason the Swift is more expensive. The Acer is just making do with a limited tilt stand—there's no height adjustment, which is a bit of a miss considering TN's paucity of vertical viewing angle.

There's also a noticeable amount of ghosting on the panel when you're using FreeSync, too, something Nvidia claims isn't present with G-Sync panels because its hardware is set up specifically for each panel to operate optimally. With FreeSync, AMD says it's up to the panel manufacturers to ensure dynamic refresh rates and pixel persistence is tuned for each screen.

Our first experience of FreeSync isn't brilliant, then. But it wasn't with G-Sync, either. This is a new technology, so the early screens aren't going to be perfect, and the Predator most certainly isn't that. At $500 it's also not really toeing the line that FreeSync isn't adding a price premium—you can pick up a 27-inch IPS 1440p panel for around $100 less.

Still though, FreeSync is great if you're already running a compatible AMD graphics card. Games certainly run much smoother than they do with V-Sync alone, and this Acer panel doesn't need any messing about with to get that up and running. We do, however, still baulk at this price for a TN screen, especially when IPS or MVA Adaptive Sync capable screens are on their way. –**DAVE JAMES**

VERDICT **7**

Acer Predator XG270HU

+ **PREDATOR** FreeSync; high refresh rate; cheaper than the Asus RoG Swift.

− **PREDATOR 2** Still TN, and not a brilliant TN; ghosting with FreeSync; fairly pricey.

$500, www.acer.com

SPECIFICATIONS

Screen Size	27-inch
Native Resolution	2560x1440
Panel Technology	TN
Refresh Rate	144Hz
Response Time	1ms
Inputs	DisplayPort, HDMI, DVI

The depth of the main characters, like Trevor, is one of *GTA V*'s real strengths.

Grand Theft Auto V

The fivequel drops on the PC… it's the best version yet

FOR A FRANCHISE that's coming up to its 18th birthday, it's amazing how little *Grand Theft Auto* has changed. *GTA V* may have the most fully realized city and well-drawn characters to date, but it's fundamentally about the gratification of being able to walk down the street and break into any car. This is also the savviest entry in the series—it has been released on two generations of consoles and now on the PC, essentially milking the same content a total of five times. Cha-ching!

That's not to diminish the PC version in any way. Rockstar may have a lackadaisical approach to our beloved platform, but the company has poured its efforts into making the Windows version as seriously bling as possible, hence that 18-month delay between its first console release and its arrival on Steam. But, aside from a whopping graphical boost, *GTA V* is fundamentally the same game.

It initially focuses on two main characters. Michael de Santo is a middle-aged man living a crime-fuelled lifestyle in the opulent Rockford Hills. He meets the impoverished Franklin Clinton by chance, which leads to an oddball paternal relationship between the pair—Michael sees Franklin as a substitute for his wayward son, while Franklin looks at Michael as the man he aspires to become.

The game's unique twist is that it allows you to switch between the two protagonists, with a third—the *Kane & Lynch* two-in-one Trevor Philips—rolling up later. Watching the narrative unfold and the characters' stories intersect is one of *GTA V*'s greatest pleasures. It's as smartly written as TV series *The Wire*, and it deals with similar themes of social and economic inequality.

MISSION MAYHEM

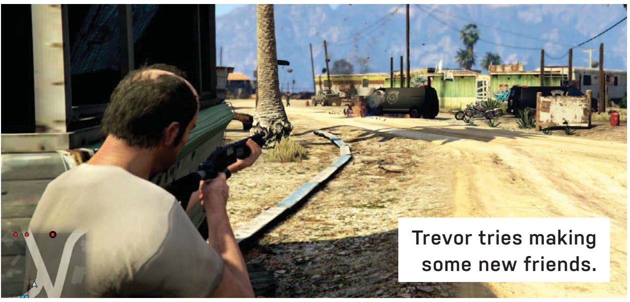
This fiendish threesome works really well. Each character is properly fleshed-out with proper backstories and motivation, and it's helped by a charismatic supporting cast. But almost every other aspect of the game was perfected 10 years ago with *Vice City*, which achieved exactly the right balance of satire, violence, and nostalgia. Every *GTA* has a redemptive story arc, with a now straight character reluctantly dragged back into a life of crime.

Missions take the same structure as the game as a whole. Everything's going well, then something goes wrong and there's an enormous gunfight or a velocious car chase. It makes you wonder how the characters run a bath or fill out mortgage application forms without the process turning into an enormous gunfight or a velocious car chase, but it's as much a part of the *GTA* experience as the simple pleasure of running someone over.

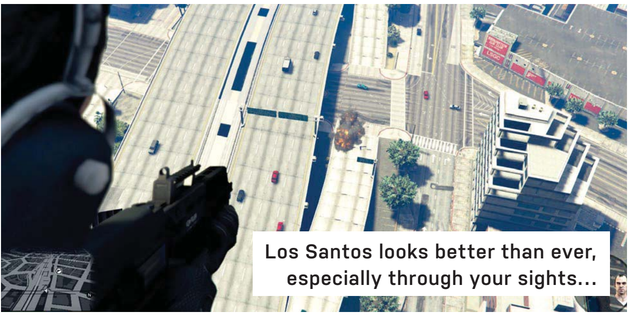
Grand Theft Auto Online extends the action into the online arena, with up to 30 players battling through the enormous gun fights and velocious car chases. Heists, especially, becoming particularly thrilling when you plan and execute them with friends. It's treated as a separate game by Rockstar, rather than a drop-in extension of the single player portion, an approach we prefer because nothing breaks the tense atmosphere of a solitary mission like Brad asking if you're up for a bank job.

Los Santos—a kind of broken facsimile of Los Angeles—forms the setting for both single and multiplayer portions of the game, and a *GTA* city has never looked better. There are times when the sun's setting and the golden hour light twinkles off the ocean, or when you're meditatively firing your tank in the forest, and you feel a sense of this being a real place. It's a huge, unbroken area, and one that's fully accessible from the word go, but it feels better to let the story introduce you to its more intimate regions.

It looks even better thanks to the sheer number of options that PC gamers are able to tweak. As well as the usual antialiasing, tessellation, and shader sliders, you can alter the density of the traffic and pedestrians (as in how many of them there are, rather than how stupid they are). It's well-optimized so you won't need high-end


Trevor tries making some new friends.

The question of whether helicopters have ejector seats is answered.


Los Santos looks better than ever, especially through your sights…

Michael's probably ruined someone's day.

PC gamers benefit from an extra vat of Turtle Wax.

Michael's breakdancing moves are pretty hot.

hardware to run it, while, if you do get that craving to make an Xbox One or PS4 owner break down and weep, it's also an awesome excuse to grab a 4K monitor and a Titan X.

Rockstar, however, hasn't just put its efforts into the graphics. It integrates a PC-specific first-person view, something that has been sorely missed in previous *GTA* adventures. The cars handle magnificently, with a tangible sense of shifting mass eliminating the usual problems of controlling cars with your W-A-S-D claw. Gunfights are made a hell of a lot easier by switching to first-person, even if the reticule gets a bit lost in brighter scenery. And, having just finished 12 years of therapy, thanks to the *Vice City* remote control helicopter mission, there's thankfully no such fiddliness here. There's even an option to skip missions if you're stuck.

There are a couple of cracks in the whole experience. If you don't have an SSD, loading times can become an issue—it takes over a minute for the game to appear. It's forgivable because the entire city is loading at once, and besides, it's always been a problem with the series's vast metropolitan areas. Also, the characters' model hair looks like it's made of Play-Doh. So the only problems with *GTA V* are that you might have to wait for a little bit, and the hair occasionally looks a bit wrong. We feel petty for bringing them up. Sorry.

EXHILARATING ACTION

There have been many challengers to *GTA*'s wipe-clean leather throne—*Just Cause* and *Saints Row* both added their own ridiculous twists to the formula, while even generically diverse games such as *Fallout* and *Skyrim* owe a little to *GTA*—it is, after all, fundamentally an open-world RPG. But there's something in *GTA*'s DNA (should that be DMA?) that stretches back to those first adventures in *Liberty City* in the late 90s. It may have become more three-dimensional in every sense of the term, but the feeling of exhilaration and acceleration as you speed down the road, followed by the worrying rasp of the nonchalant dispatcher on the radio, remains the same. And long may it continue. **–HENRY WINCHESTER**

VERDICT
9
KICK ASS!

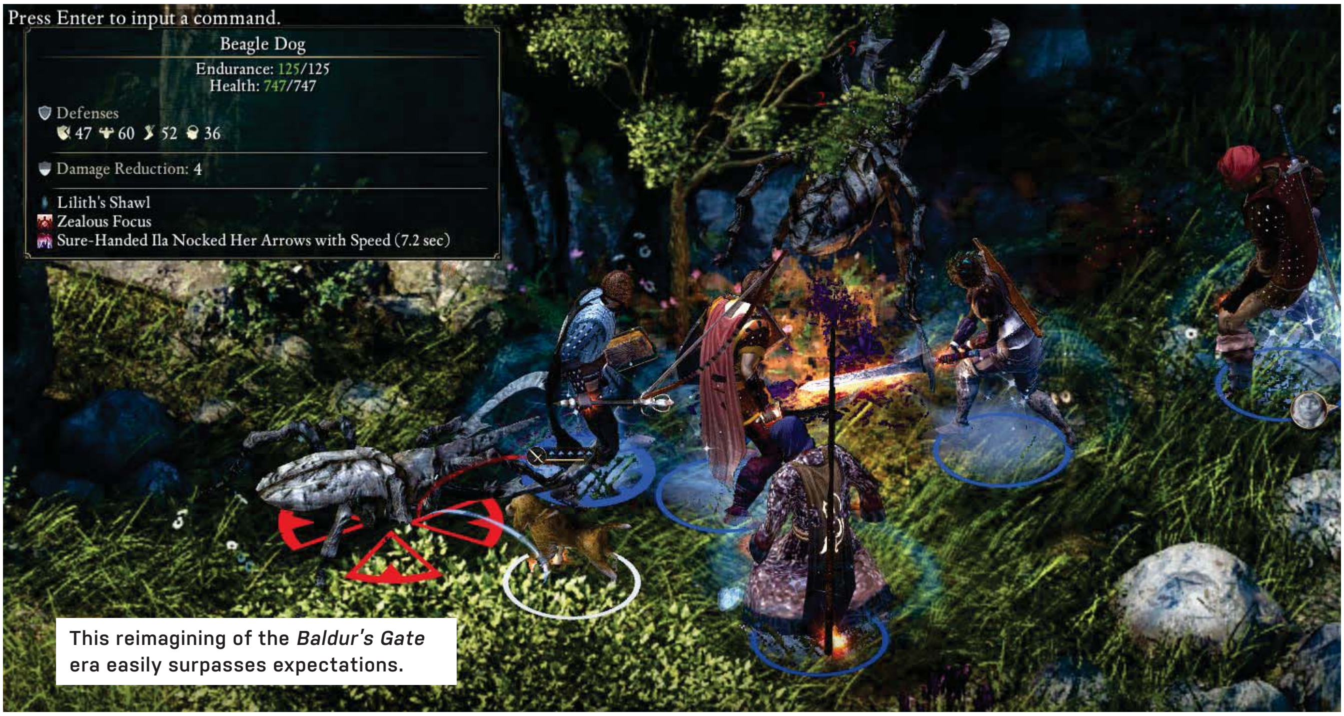
Grand Theft Auto V

ACCELERATOR Best version yet; well optimized; proper three-way storytelling.

BRAKE Takes ages to load; characters' hair can look weird. Look, we have to put something here, OK?

RECOMMENDED SPECS Intel Core i5-3470, 3.2GHz/AMD X8 FX-8350, 4GHz; 8GB RAM; GTX 660 2GB/AMD HD 7870 2GB.

$60, http://bit.ly/J2MTcN, ESRB: M



Press Enter to input a command.

Beagle Dog

Endurance: 125/125

Health: 747/747

Defenses

47 60 52 36

Damage Reduction: 4

Lilith's Shawl

Zealous Focus

Sure-Handed Ila Nocked Her Arrows with Speed (7.2 sec)

This reimagining of the *Baldur's Gate* era easily surpasses expectations.

Pillars of Eternity

The Kickstarted RPG that may stand forever

A KICKSTARTER IS NOT A GUARANTEE. Many of us learned that the hard way. Looking at the list of games we've backed, it ranges from the disappointing (*Fist of Awesome*), to the misleading (*Godus*), to the never-appearing (*Clang!*). And if you backed the *Project Eternity* Kickstarter, which promised a return to the days of *Baldur's Gate*, you did so with the full knowledge that the developer Obsidian had a string of wonderful but mostly buggy projects to its name, so you shouldn't expect too much.

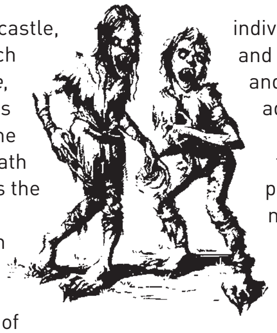
Perhaps the company's reputation for unfinished games was due to publisher pressure to finish on time. Because here, working at its own pace, Obsidian has excelled. *Pillars of Eternity* is a perfect recreation of that *Baldur's Gate* era. There's the mysterious plot and the character-soaked exploration team faced with endless side quests. There's the glorious city of Defiance, the subterranean crystals of Od Nua, and the dragonbone-strewn woods of Crossing. And then there's the chords of battle, swelling to Durante's sonorous fanatical ranting against the dull hum of a city center.

Crucially, though, it's been brought up to date, learning particularly from the more recent Bioware titles. Early in the game, for example, you acquire an abandoned castle, Caer Nua, which is in ruins. Much like *Mass Effect* or *Dragon Age*, you can upgrade it, acquire troops to guard it, and gain an income from it. The dungeon underneath it, Od Nua, feels almost as big as the rest of the game put together.

But you might never go down into Od Nua. The main quest, following your ability to speak to the dead and the mystery of children born without souls, is long enough. Even finishing the game, you could never explore half the side quests that *Pillars* has to offer. You may never find out what the priest Durante's involvement in the death of a god was, or why the elf wizard, Aloth, breaks into Gaelic dialect when he gets angry, or what the soldier Eider's brother did in the Godhammer war.

BIOWARE AWARE

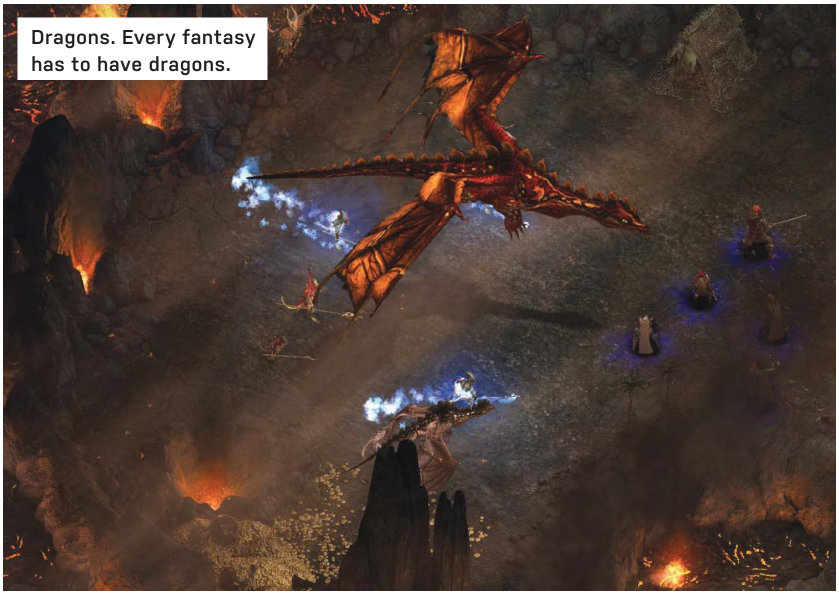
That's just your party. You may never encounter the forlorn wraith in the lighthouse, find the rebellion-god Skaen's hidden temple, or any of a hundred other side quests. And the storyline is mature, too. The sadness of families at their doomed Hollowborn children, plus the desperation of leaders and individuals to find explanations and solutions, is both believable and sad, as are those taking advantage of the panic.

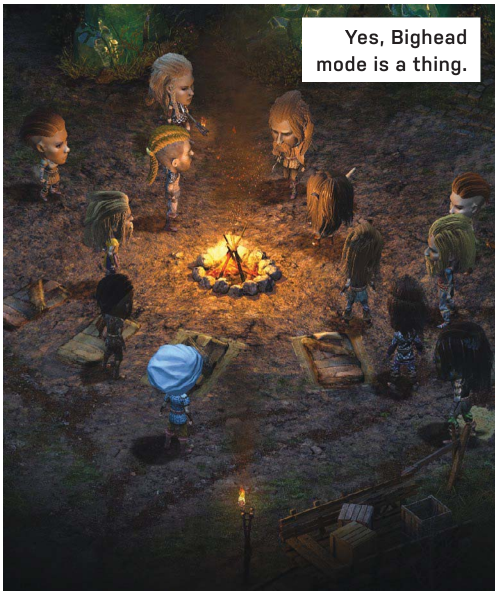


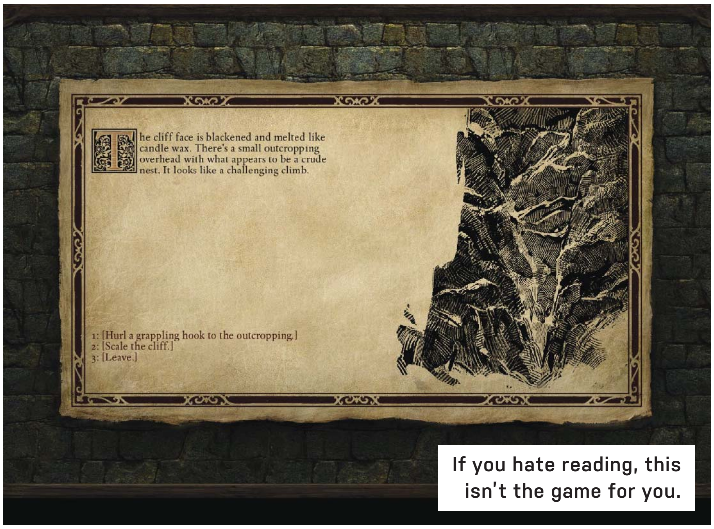
That complexity extends to the look. You'll probably play much of the game at maximum view distance, but it's well worth diving in to take in the detail of the world. Though isometric, it's like looking at a painting. Not the greatest painting, but almost as good as the stylings of *Planescape: Torment*. And the UI has learned much from the more modern Bioware games, while still retaining that stat-heavy appearance, all of which can be turned on or off. You can even have the game auto-pause when, for example, you encounter an enemy or a character nears death.

Oh, and did we mention it's long, in a way modern games just aren't, save for the *Elder Scrolls* series? Even focusing on only the main quest, you'll take several days to get through it. Do all the side quests and a hundred hours could easily disappear. If you're an obsessive-compulsive hoarder, you may never stop playing.

And it's heavy on the words, too. The language may occasionally spill into overly wrought fantasy babble, but that's rare.

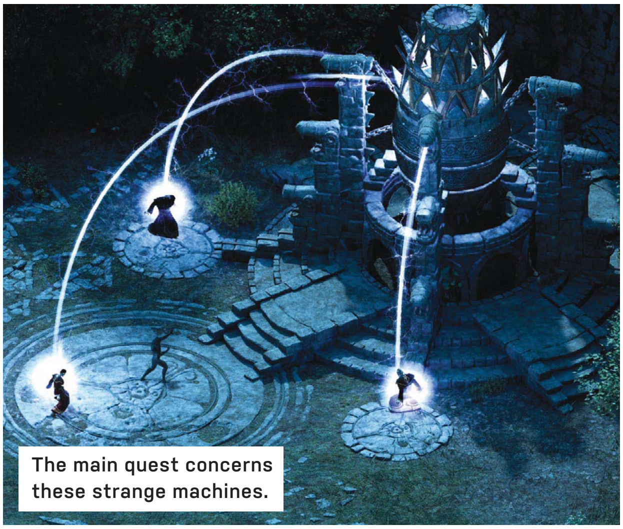

Dragons. Every fantasy has to have dragons.


Yes, Bighead mode is a thing.


The cliff face is blackened and melted like candle wax. There's a small outcropping overhead with what appears to be a crude nest. It looks like a challenging climb.

1: [Hurl a grappling hook to the outcropping.]
2: [Scale the cliff.]
3: [Leave.]

If you hate reading, this isn't the game for you.

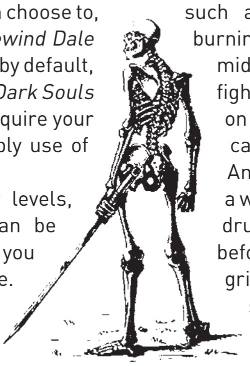

The main quest concerns these strange machines.

It's mostly plainly written, but there are novels of evocative language that fill in the descriptive gaps between the delightful art. Sometimes it's spoken, sometimes it's not (with no reasoning why). Every character has, well, character. Carefully sketched stories drag you from one hand-crafted location to another.

REALTIME COMBAT

Though you can talk your way through many situations, sometimes you can choose to, or be forced to, fight. Like *Icewind Dale* of yore, the combat system is, by default, fairly brutal—not quite at the *Dark Souls* level, but harder fights will require your absolute attention and possibly use of the pause menu.

Luckily, the five difficulty levels, plus the Ironman option, can be changed on the fly, allowing you to tweak your experience. Combat is played out through a realtime system, where you can pause at any time to issue orders—exactly the classic Infinity Engine system from the old *Baldur's Gate* games. Characters can, if you're not careful, die permanently—which means an end to any associated quests—but you can create more generic adventurers to replace them, albeit without the unique story.



It's not perfect, mind. For example, it's hard to be aware of the various types of damage and their particular defenses—such as crushing, slashing, piercing, burning, and freezing—while in the middle of a fight. Unless you've lost a fight 10 times in a row or are playing on the hardest difficulty level, you can muddle through most combats. And the variety of spell options with a wizard, a priest, or an overpowered druid is frankly bewildering, even before your wizard starts swapping grimoires. But you'll persist all the same, mainly because the spell effects are so cool.

Pillars of Eternity has taken so much from *Baldur's Gate*, but most of all it's taken the spirit of the Infinity Engine games, which had barely felt the touch of age, and applied modern polish. A Kickstarter appeal is certainly not to be seen as a guarantee, but an isometric Obsidian RPG, on the other hand, *is* a guarantee of thoughtfulness and quality, it seems. **–DANIEL GRILIOPOULOS**

VERDICT
9
KICK ASS!

Pillars of Eternity

+ FOREVER A staggering achievement in scope, breadth, and length; the rich dialogue and characters carry you through a strange-but-familiar world.

− NEVER Can be a bit too wordy.

RECOMMENDED SPECS Intel Core i5-2400 3.1GHz; 8GB RAM, AMD Radeon HD 7700 or Nvidia GeForce GTX 570.

$45, eternity.obsidian.net, ESRB: M

LAB NOTES

TOM MCNAMARA **TECHNICAL EDITOR**

The Pipes Are Calling

Technical editor Tom McNamara bids farewell

WHEN PEOPLE LEAVE *MAXIMUM PC*, they usually say that they can't believe how quickly the time has gone by. Because when you do something you love, and you work with good people, the hours just disappear.

That's the way it's been for me. I feel like I just got here—and yet, I feel like I've known everyone for a lot longer than two years. So it's not an easy thing to walk away. But, as the wise men say, the only constant is change. Sometimes you stumble upon a new port of call. I've had a great ride here, but the time has come to move on.

It's also been a privilege to write stories for you, the reader. I enjoyed emailing back and forth with some of you, talking about builds and components. I think I was able to help some folks make the most of their money and learn new things about computers. I love being able to do that, and getting a salary to do so almost feels like cheating at life, even now.

I've also gotten to build PCs every month with some really amazing hardware, so I've learned more about gear than I ever would have otherwise. But there are still a lot of people out there who know more than me, and many of them are our readers. They've kept me on my toes, and I'm glad that they were along for this ride, too. So thank you, and may the road rise up to meet you.

SONY 'DESKTAB'
Is the public ready for a 20-inch, 11-pound tablet?
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AV BATTLE
10 popular antivirus suites brutally tested!
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Wee PC continues campaign against game consoles!
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PLUS: 7 WAYS TO FIX A BUILD THAT WON'T BOOT!
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CLOUD BACKUP
CrashPlan and Backblaze square off!
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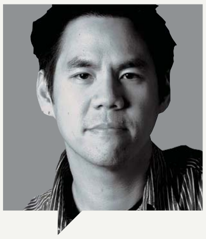
INTEL NUC
Hands-on with this little DIY PC
PG. 68
Future

The cover of my first issue as an editor at *Maximum PC*.



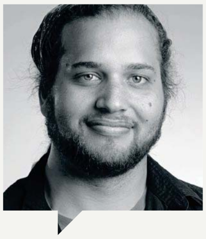
JIMMY THANG

Online Managing Editor

Sometimes, I just need to shut the hell up. This advice often applies to my life in more ways than one, but in this instance I'm referring to *GTA V*.

Considering that the game originally came out on the consoles back in 2013, it seems like I've been waiting forever for the PC port. The barrage of delays certainly didn't help, and I was beginning to write off Rockstar as a lazy PC developer. Now that the game is finally out on PC and is truly the definitive version, I take back everything I said. The game is beautiful, runs relatively well, and offers a ton of exclusive features.

Rockstar, if you're reading this, don't listen to stupid people like me. You keep doing you, Rockstar.



ALEX CAMPBELL

Associate Editor

When I joined *MaxPC*, I'd few games on my Steam account. My rig was mostly for photo editing and web development. Now, I've an excuse to start gaming again, and I've been getting into *Arma 3*.

My first gaming experience was a first-person shooter, and I've been a fan ever since. Over the years, many shooters didn't offer me the depth I was searching for, but *Arma 3* made me hit the deck the first time I heard shots over my head. I often never see the enemy who kills me, with details like ricocheting tracer rounds bringing home that air of realism. There are many other games I'd like to play on Steam (I've started *This War of Mine*), but I'm not sure I'm ready to leave Altis just yet.

First Look: Intel RealSense Developer Kit

Like a Kinect for serious business

USER INTERFACES HAVEN'T CHANGED much since the first home PCs came to market. Indeed, the keyboards and mice that we're all accustomed to are one of the selling points of PC gaming. For specialized inputs, there are steering wheels, flight sticks and throttles, gamepads, and trackballs. Designers and artists, meanwhile, have drawing tablets for input that resemble putting pen to paper.

Intel has been working on developing a 3D camera interface that will attempt to take physical objects out of the picture. They're calling it RealSense, and it's already available in a number of laptops and ultrabooks. We managed to get our grubby paws on an Intel RealSense Developer Kit front-facing camera built by Creative, and got to playing with it to see what all the fuss was about.

First off, the RealSense camera isn't one camera, but two. The RGB camera is a fairly standard 1080p CMOS sensor, but the second camera comes in two parts: the infrared laser projector and the IR sensor. While you're busy smiling at the camera like an idiot, the IR projector is shining invisible wavelengths of light on your mug. The IR sensor then sees the light and calculates the distance to each spot, which determines depth and allows RealSense to create a 3D mesh. It's basically a miniature scanning laser range finder that's firing at your face.

And the imaging isn't limited to faces, either. Examples in the software development kit show off the ability to detect 3D hand models, as well. A quick flip of the proverbial bird generated a less-than-perfect 3D skeleton-like hand model, but it was basically pretty accurate in reproducing gripping and open palm postures of the hand.

The Intel/Creative SDK also has two mics below the optics. Laptops have had dual mics for a while, so this alone isn't anything new. A software example in the SDK was pretty snappy at speech recognition. Even when using a bad fake Russian accent, the software was able to pick up some of the silly crap we were saying. While we only got to play with the front-facing camera dev kit, the technology is also being applied to rear-facing cameras for mobile devices.

And all this jazz amounts to what, exactly? Casual views of the technology will see parallels with the Microsoft Kinect. Both have IR scanners paired with the typical RGB cameras. From what we gathered, front-facing RealSense implementations focus on input that is close to the device, not halfway across the room. Instead of jumping around, you'll be playing "I'm not touching you" with your device. Intel's website says that RealSense will replace the W-A-S-D keys in gaming, but we have a really hard time imagining waving our hands in front of our screens while playing *GTA V*.

Coupled with emerging virtual and augmented reality headsets, the use of RealSense could have some really interesting consequences. You could, theoretically, surf the web with a virtual screen projected on a wall using an imaginary keyboard. That's cool. Mobile apps could potentially determine whether you're happy or upset by reading your face mesh with the front-facing cameras. That's a bit unnerving.

The SDK includes code examples for C++, JavaScript, C#, Java, and Unity, so programmers can develop native or web applications for the hardware. If you're a developer looking to create cool or creepy apps, dev kits on Intel's website go for $100. If you're like the rest of us, you can wait for more devices to roll out with RealSense, and the apps that will follow. **–AC**

Intel teamed up with Creative to build the RealSense dev kit.

GEEK TESTED & APPROVED

Google Cardboard

UNLESS YOU'RE A GAME DEVELOPER or tech journalist, chances are you haven't gotten the chance to try on a virtual reality headset yet. VR is cool, but you'll have to wait a little while before you can be totally immersed in VR games; the first consumer models will hit the market later this year.

Well, if you just can't wait to strap a box to your face, you're in luck. Google's Cardboard gives users a sneak peek into the world of VR. Best of all, it requires no more than its corrugated cardboard kit and your smartphone. If you're handy with a hobby knife, you can even build your own using Google's instructions.

Cardboard is as simple as that: a cutout cardboard pattern with a pair of plastic lenses, a couple of magnets, some adhesive, and a bit of Velcro. The display is nothing more than your Android phone and an app that splits the display into two images. You can "click" using the magnetic trigger on the side of the viewer, which is great, provided you don't lose the magnet. (If you do lose the trigger, you'll have a hell of a time navigating interfaces, as we found out.)

There isn't a vast sea of content for Cardboard, but the few VR games and short films that are available do a good job of showing off VR's potential. Frame rates were less than ideal on a Galaxy S3 we tested, but a newer, more powerful phone will result in a better experience.

You'll want to make sure that your phone's got plenty of juice, as Cardboard apps are power hungry. They'll also turn your phone into a nice hand warmer for those in chillier climates.

You can find Cardboard kits ranging anywhere from $20 to $85. If you've always wondered what VR looks like, give Cardboard a try. **–AC**

$20–$85, http://bit.ly/1vgT12R

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Future-Proof Rigs
> Overclocking
> Frequency in Formulas

Eye On The Future

I'm heading off to college next year, and my plan right now is to run an ultrabook and a sub-$1K small form factor box in the dorm room. I'd like to future-proof this box as much as possible. Looking into DDR4, Haswell-E, and X99 chipsets, I've noticed two things. For one, there are no midrange offerings from Intel, and two, there are little-to-no small form factor boards on the market. Might it be worth waiting for a wider range of offerings, or should I go back to looking at Devil's Canyon, Z97, and DDR3? Will Skylake be the answer?

—Alex

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hi, Alex. If you're looking for an affordable X99 Mini-ITX setup, it's like trying to find a cheap Ferrari… that can also turn invisible. X99 is an enthusiast platform, and outside of Asrock's recently announced X99E mobo (which we haven't had the pleasure of testing), there really isn't anything out there that fits your needs at this point. Having said that, if you can afford a Devil's Canyon build, that should tide you over for a long while. If gaming is your biggest interest, a 4790K shouldn't be a bottleneck for future graphics cards for quite some time. Plus, it's just much cheaper overall and you won't have to pay the premium for DDR4.

[NOW ONLINE]

HOW TO REMOVE WINDOWS MALWARE FOR FREE

Malware is like the new common cold. As much as you try to avoid it, it's bound to infect you at one point or another. Instead of affecting your body, however, it—arguably much worse—affects your PC! Whether it comes in the form of changing your search engine or inundating you with annoying pop-up ads, it can make you feel sick to your stomach. Luckily, you don't have to sell your kidney to fix your computer. In our online guide, we show you how to remove malware for free: how to scrub down your browser, kill the malware with AV software, and more. http://bit.ly/MPC_malware

You can fix your malware-infested rig for free.

Too Hot To Handle?

I'm thinking of building my own PC, but I've a quick question about my CPU and mobo choice. I want to couple the AMD FX-8320 8-core Black Edition with the MSI 970A-G43 AMD 970 ATX board. I've seen this board is compatible with the CPU's 8 cores, but I've also seen the mobo's lack of a VRAM heatsink can cause overheat and fail quickly, some saying within a month. I've also seen the only way to achieve a stable board is to undervolt the CPU. Are these claims true? Does this affect systems running at core clock or just overclocked?

—Andy

TECHNICAL EDITOR TOM MCNAMARA RESPONDS: Hey, Andy. Voltage is directly related to clock speed, so undervolting will reduce the amount you can overclock. In some cases, it may eliminate the possibility. But if you save up a little more for the 970A-G46, it has a sizable heatsink on the voltage regulator modules (VRMs). Ordinarily, that will address overheating.

VR Versus AR

In the article comparing the Oculus Rift with the HoloLens, you gave the Rift the win in gaming and entertainment. I want to point out some things you may have missed. Five or six friends playing *D&D* all wearing the HoloLens can see the realistic terrain,

↘ submit your questions to: comments@maximumpc.com the castle, and the real-looking monsters and character figures. Or playing *Fantasy Flight*, you and your fellow players are in a Death Star corridor and get charged by storm troopers. You pull out your lightsaber and it glows! (Pretty exciting if you ask me, am I alone?) How about 3D plays from Broadway on your table top, 3D movies that don't need a TV. Or the Super Bowl on your table. I think it's at least even between the two technologies. **—Mark**

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hi, Mark, and thanks for your feedback. Let me start by saying that, having tried both, I'm greatly excited about HoloLens *and* Oculus's VR HMD. Considering they're not out yet, my opinions at this point reflect which way I feel the wind is blowing. When final versions come out, this could change. To respond to your question, HoloLens definitely could reinvent gaming and entertainment. I like what you said about tabletop gaming, that could be fantastic. I'm a little concerned, however, it might not pick up steam (at least for a while), considering the HoloLens could be really expensive at first. It might be difficult to convince five friends to buy them. This could lead to a chicken-and-egg scenario in which game developers don't make the app because it requires so much from users. While you could say the same about VR HMDs, you can at least get your multiplayer fix via online matches.

In regard to AR lightsabers and spaceship experiences, if it's pulled off, well, it could be a game changer. At the same time, I worry it might be hard to program for because 1) everybody has different room setups and 2) this is very alien territory for developers. At least with VR headsets, game devs can already, more or less, understand the dialect. With AR, it seems like they have to learn an entirely new language. I think both experiences have the potential to be game-changing, and I can hardly wait.

> “HOW ABOUT BROADWAY PLAYS OR THE SUPER BOWL ON YOUR TABLE?

Fishy Laptop

Your article, “Something Fishy this Way Comes,” in the May issue, came true for me. I purchased one of the affected laptops and Superfish made itself known in a hurry. I got so disgusted with this and all of the other crap Lenovo puts on its units, I decided to do a complete wipe and install Windows 8 Pro. Thanks for the unveiling, it brought my sanity back. **—Stacey**

Funny Math?

In Tom Halfhill's May column, he uses a formula: power = voltage squared times frequency. Therefore, the 60-watt lightbulb in my desk lamp uses 864,000 watts (120x120x60 = 864k)? Please explain. **—Herm**

CONTRIBUTING WRITER TOM HALFHILL RESPONDS: Hello, Herm. Thank you for caring enough about my *Maximum PC* column to question a possible mistake. There's no mistake, though. Engineers use “frequency” to mean many different things. In general, it means “how often something happens.”

For the power equation I cited (P=V^2F, or Power = Voltage squared times Frequency), “frequency” means a microprocessor's core clock frequency. That's not the same as the alternating current (AC) frequency of the mains power lines that illuminate your lightbulb. Core clock frequency is the number of “ticks” per second from the oscillator that regulates the processor's digital logic circuits. AC frequency is the number of back-and-forth flows of current between your lightbulb and the power source.

The power equation I quoted applies only to synchronous (clocked) digital logic. Your 60W lightbulb uses 60W, which is W=VA (Watts = Voltage times Amperes). So, if your mains power is 110V (US standard), then your lightbulb is drawing about 0.55A. However, sometimes lightbulbs are confusingly labeled “60W” to indicate they emit as much light as a traditional incandescent 60W bulb. The correct measure of brightness is lumens. ⏻

Facebook Polls

AR Awesomeness

This month we asked our Facebook buddies about ideas for AR uses. We'd pair HoloLens with go-karts for real-life *Mario Kart*! Here are some of the best responses.

Tony Billingslea: It depends on the activity and the safeguards in place. What happens if you're distracted by an icon, flip the go-kart, and break your neck? Who does your family sue, the go-kart track or Microsoft?

Dominic Santoro: This is why we need independent drive electric go-karts, so you can spin out after hitting banana peels.

Thorsten Balthes: Screw go-karts. I want *Mario Kart* for rush-hour traffic. Nothing more satisfying than firing a shell at that jerk who just cut you off!

Ethan Fougner: Zombies and Laser-tag guns and HoloLens.

Marcia Allen: I'd like to try stuff like AR Jenga you could play remotely with friends. Maybe AR group Lego city builds.

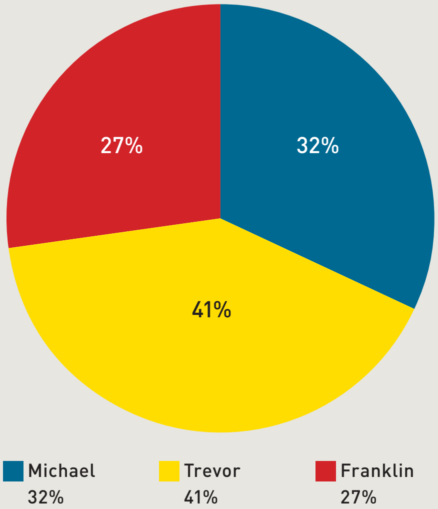
Loren Sorenson: Car repair paint by numbers. Menu items, prices, reviews while looking at a restaurant. For nurses/doctors, patient information while looking at a patient. For driving, speed data surrounding vehicle proximity, translucent overlay directions. Augment the viewing of a movie or show, etc.

Eithan Smalley: *Mortal Kombat*!

Lucas Kaelin: Zombie escape running.

Rob Rounthwaite: For sure *GoldenEye 007* original for N64.

Who's your favorite lead character in GTA V?



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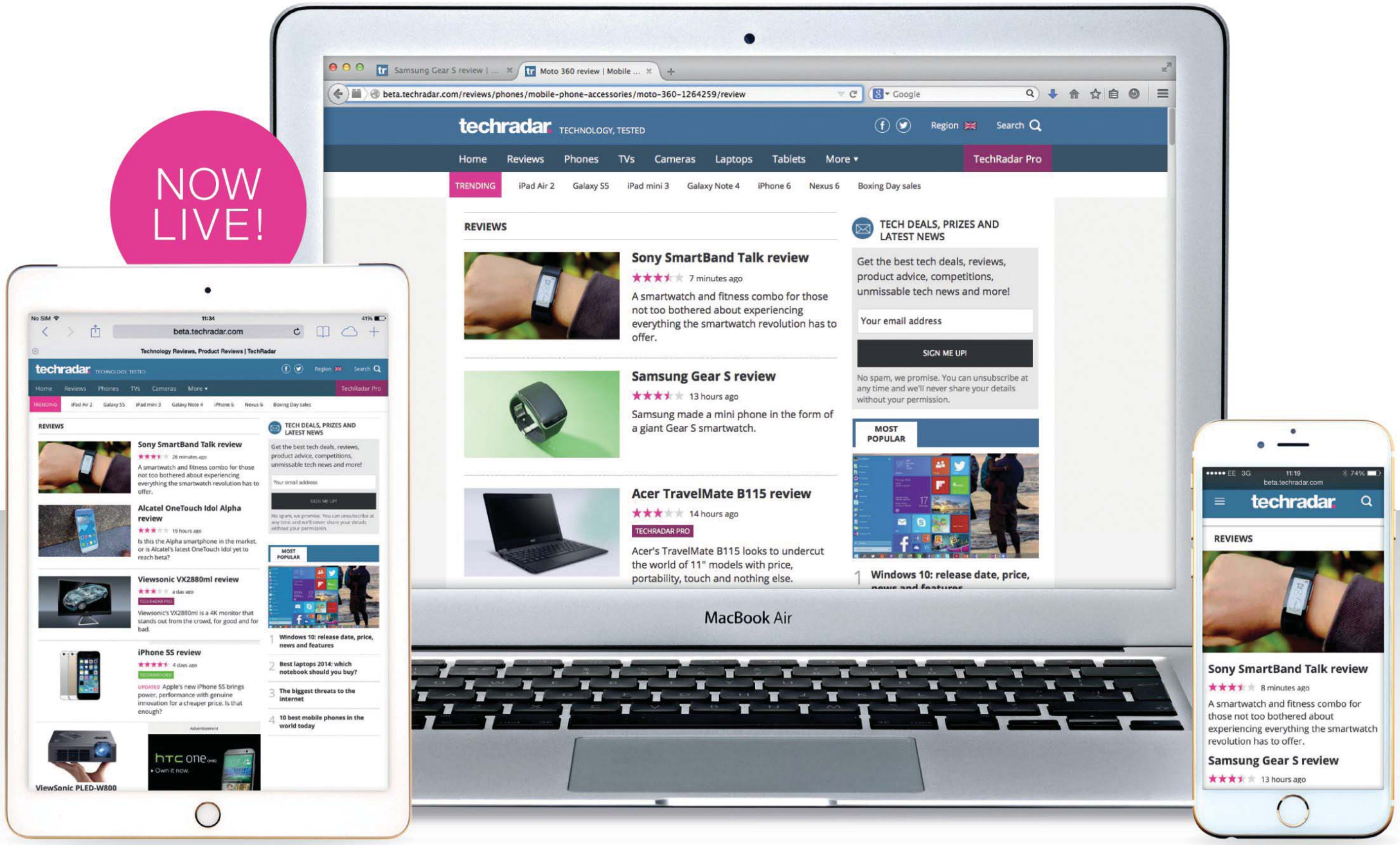

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PART			PRICE
Case	NZXT Source 210 Elite		$50
PSU	Corsair CX500M 500W		$60
Mobo	Gigabyte H97-D3H		$95
CPU	Intel Core i5-4150		$120
GPU	Gigabyte Radeon R9 285 GV-R9285WF2OC-2GD	**NEW**	$210
RAM	2x 4GB Crucial Ballistix Sport DDR3/1600	**NEW**	$53
SSD	240GB SanDisk Ultra II	**NEW**	$88
HDD	Seagate Barracuda 1TB		$60
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $836

INGREDIENTS

PART			PRICE
Case	Corsair Vengeance C70		$108
PSU	Corsair RM 850W	**NEW**	$110
Mobo	Asus Z97-A/USB 3.1	**NEW**	$155
CPU	Intel Core i5-4690K		$210
Cooler	Corsair H100i GT	**NEW**	$100
GPU	XFX Radeon R9 290 Double Dissipation	**NEW**	$240
RAM	2x 4GB Crucial Ballistix Sport DDR3/1600	**NEW**	$53
Optical Drive	Samsung SH-224DB/BEBE		$20
SSD	256GB Samsung 850 EVO		$100
HDD	Seagate Barracuda 3TB ST3000DM001		$103
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $1,299

YOU COULD ARGUE for an AMD system with an FX-6300, which has six cores (or six integer units, depending on how you count it), but the dual-core Intel Core i3 and its Hyper-Threading still give comparable AMD chips a run for their money, plus you can upgrade to a beefier chip later. We stick with AMD on the videocard front, because the Radeon R9 285 is still a great card despite some recent price increases. It has 2GB of VRAM instead of the 3GB on the 280 and 280X, but that's unlikely to be a problem as long as you don't go past 1080p. In other news, SSDs in the 250GB range are now within the reach of this budget, and the SanDisk Ultra II is a great performer.

AS ITS NAME IMPLIES, the Asus Z97-A/USB 3.1 has integrated USB 3.1 support. This connection type is supposed to be twice as fast as USB 3.0. So you'll be prepared for super-fast external SSDs, and you can get up to 100 watts of power from this hookup as well. We've switched our CPU cooler from the Cooler Master Nepton to the Corsair H100i GT because the latter fits in more cases in this price range (chiefly mid-towers). Prices on power supplies fluctuate a lot, and this time we settled on an 850-watt Corsair RM. It's gold-rated, so it's quite efficient, and it has a slightly curvy look. Prices on the Sapphire Tri-X Radeon R9 290 have crept up, so we've switched to the XFX.

TURBO

THE CORSAIR 780T CASE is roomy, cool-looking, and the side panels go on and come off very easily, yet they are secure. The large fans are also pre-wired into a multi-speed fan controller. The plastic foot that elevates the case off the ground doesn't look tough, but we've tipped it with the complete build inside and never saw the foot bend. It's a nice bit of gear.

USB 3.1 ports can offer twice the speed of USB 3.0 and up to 100 watts. Think of all the phones and tablets you could charge! Try not to go mad with power. The Asus X-99 Pro is a premium motherboard in its own right, with lots of enthusiast features and a sort of retro-futuristic look. The Intel Core i7-5820K plugged into it has six sleek CPU cores that'll take pretty much anything you can throw at it, and the Radeon R9 295X2 will rock 1440p gaming for about $500 less than a pair of Nvidia GTX 980s. That saving allows us to double our SSD capacity to 1TB and bump the PSU to 1,600 watts.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best.

INGREDIENTS

PART			PRICE
Case	Corsair Graphite 780T		$170
PSU	EVGA SuperNOVA G2 1,600W	**NEW**	$280
Mobo	Asus X99-PRO/USB 3.1	**NEW**	$293
CPU	Intel Core i7-5820K		$390
Cooler	Cooler Master Nepton 280L		$100
GPU	XFX Radeon R9 295X2	**NEW**	$600
RAM	4x 4GB Corsair Vengeance LPX DDR4/2400	**NEW**	$213
Optical Drive	LG Blu-ray Burner WH16NS40		$70
SSD	1TB Samsung 850 EVO	**NEW**	$390
HDD	Seagate Barracuda 3TB ST3000DM001		$103
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $2,709

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